In this Issue

LIQUID OR AIR-COOLED ENGINES?

By General George H. Brett

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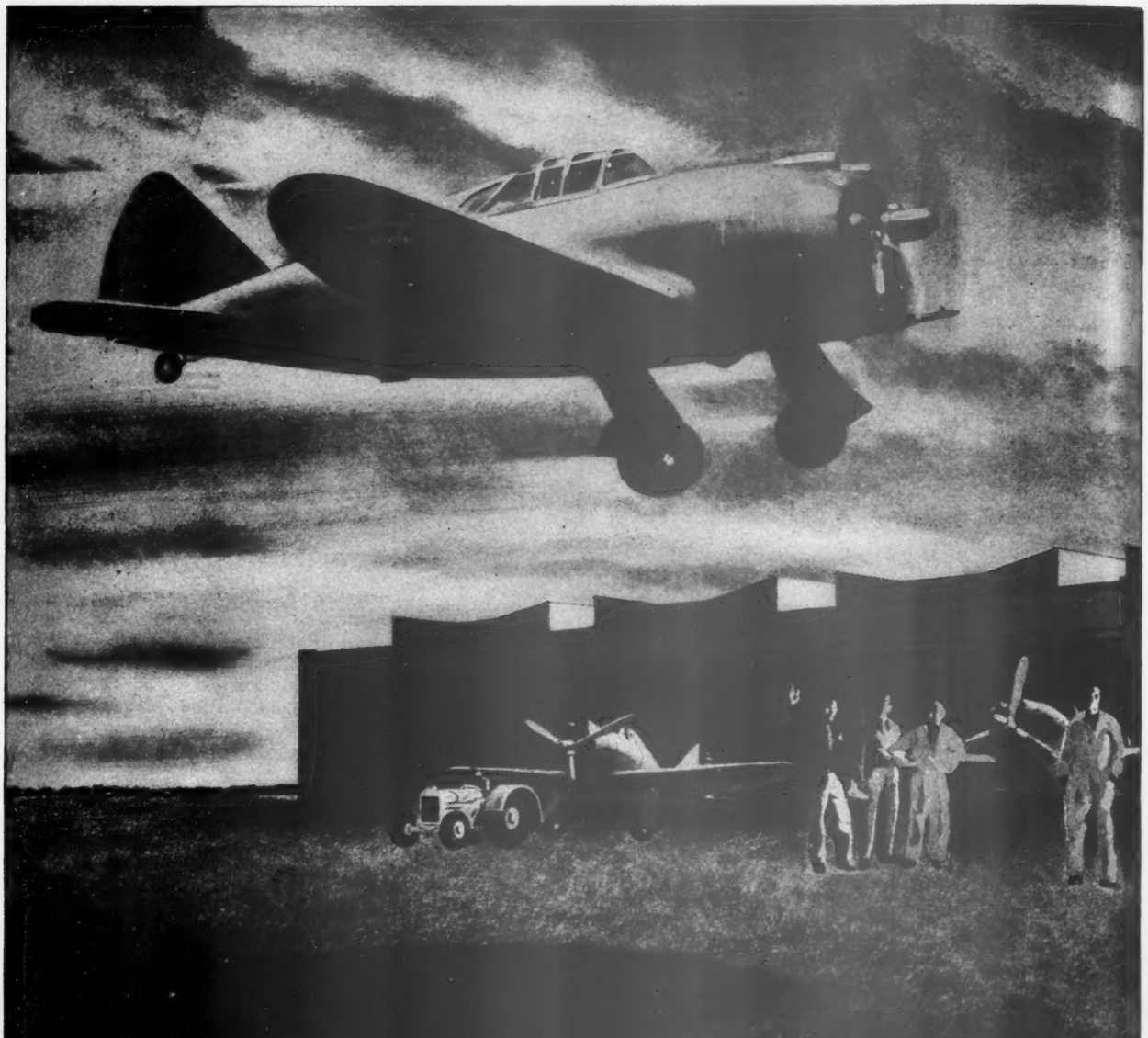

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REPUBLIC AVIATION

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» THE PEOPLE of the United States and our industries have been criticized on the grounds that they have not realized the urgency of the present emergency, that their defense effort has not been "all out." In almost the same breath, some of these critical voices have made persistent efforts to decrease the tempo of our defense program by needless impairment of vital communications behind the lines. Last year the production of commercial airliners was arbitrarily curtailed without any discernible increase in military production resulting from the virtual suspension of commercial manufacturing. Next came the process of stripping the airlines of so-called surplus equipment in which the transport operators tightened their schedules and complied even though it impaired their services as any habitual air passenger will realize. Now more planes are wanted and there is talk of cutting schedules on some of our high traffic density routes, and curtailing the supply of aviation gasoline. All this is being done in the name of "aid to the beleagured democracies", but it is the most short-sighted variety of aid. Let us look at a few facts and figures on the present status of the domestic air transport situation.

Demand for airline service is increasing tremendously because of the defense production program which places unreasonable requirements on all branches of industry. The only way you can increase production quickly is by making use of all facilities for speed. The year 1941 will be the period of greatest expected acceleration in defense production. Yet the airlines, on May 1st of this year, were operating with 350 planes compared with 358 in 1940. And this number is threatened by still greater reduction.

Away back in April, the domestic airline load factor passed the 60 percent point and this month it will probably reach 65 percent, which is generally recognized as being the maximum for this industry. Yet the airlines are trying to push this figure toward the 70 percent mark—a performance little short of miraculous.

It requires no ingenuity to recommend that schedules be cut down over high traffic density routes such as New York-Washington, New York-Boston, or New York-Chicago. But these routes are in the very heart of our defense production and a recent survey showed that 80 percent of the New York-Washington passengers, and a very high proportion of all air passengers out of New York were engaged on defense missions (see AVIATION, August, page 154).

But that isn't all. The advocates of schedule curtailment apparently have never seen an airline routing chart. If they would take the trouble to look at one they would soon learn that no airplane equipment is assigned exclusively to the New York-Washington or New York-Boston "merry-go-rounds." True, an airplane may make one or two round-trips a day over these routes but that is not a sufficient day's work for an airplane under present intensive use. After its "merry-go-round" schedules are completed the same plane must get out over the line to provide through service to other points in a division. For example, one plane leaves Boston in the morning for New York, makes a round-trip to Boston and return, then sets out for Washington and Chicago via Charleston, West Virginia, Cincinnati, and Indianapolis. Also within the 24-hour period the same ship flies to St. Louis, Tulsa, Fort Worth and Dallas. There it is made part of an eastbound transcontinental run back to Boston via Nashville, Washington, and New York. This is typical of an airplane's day. So what good would it do to curtail the New York-Washington or New York-Boston part of the day's work? Neither of these runs amounts to much over an hour of the very full day, and their elimination simply wouldn't release any airplanes from regular scheduled service.

Unfortunately these airplanes must be maintained and each ship requires about 14 hours of servicing for each 10 hours in the air. We hope that this apparent lack of ordinary common sense will not reach the point of suggesting skimping on maintenance and overhaul time.

So far we have been talking about DC-3s. We are still mystified by the sudden preference for these airplanes by the lease-lend countries, while there are so many Lockheed Hudsons lying around on both sides of the Atlantic. During the typical week of July 14 to 21, the inventory of Lockheed Hudsons at the factory field and Lockheed Air Terminal for the six days was as follows: 200, 153, 150, 152, 156, and 142. This is a properly comforting backlog. But the maximum number of Hudsons that can be ferried across in a month is about 100, which will not absorb this backlog very rapidly.

It requires but five days to convert the Hudson Bomber into a passenger

Just a lariat toss—

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troop transport with a range of 1600 miles or double that of a DC-3 or a DST, for 16 passengers. The Hudson has a 20-mile increase in cruising speed over the other types. And the conversion cost is lower for the Hudson and the British pilots and instructors are more familiar with it than they are with DC-3s.

No one denies the need of the British and Chinese for troop transports, although this need should have been recognized way back in the invasion of Norway. But the British and everyone else must realize the wisdom of the Nazi philosophy of "Depth of Armament", discussed in these columns a couple of months ago. There can be no effective frontal action with inadequate support from behind the lines. We cannot give all-out aid to anybody by crippling the communications so vital to the acceleration of our industrial effort. We have gone too far in this direction already. In the sincere interest of true aid to the democracies, let us leave what is left of our airliners on the airlines.

» IN TIME OF WAR, prepare for peace! After the war the aviation industry will probably be more vulnerable to drastic readjustment than any other industry in the country, because it is being expanded to a greater degree than any other industry. When the shift comes to a new peacetime economy, every industry will naturally strive to attain for itself economic and political priorities. If the aviation industry hopes to receive favorable consideration on a generous scale when that time comes. it must get busy and start preparing for peace *now.*

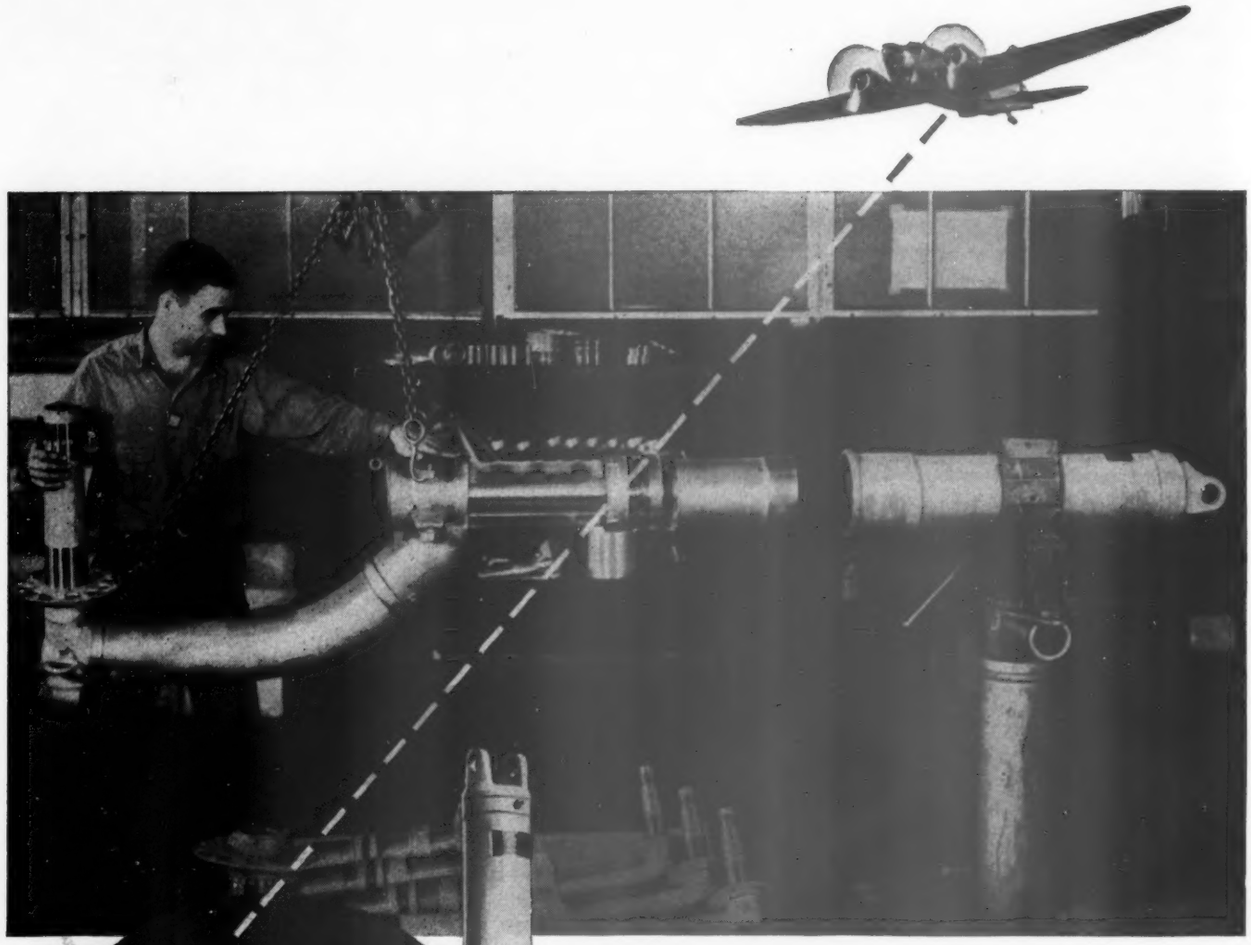
» AN INSTITUTE OF ECONOMIC RESEARCH in aviation, to aid constructively in the development of sound national air policies, is the first step needed. The Nazis have long had a similar agency, the "Institute of Commercial Sciences for Aeronautics" at Stuttgart. Nazi penetration of world air traffic lanes has been planned, not haphazard. There are immense undeveloped possibilities in the commercial uses of aviation as a persuasive instrument of national policy, politically, socially and economically. Properly to develop these possibilities, economic research in aviation is urgently required—painstaking, competent, continuing research, to serve as the basis for an adequate national air policy.

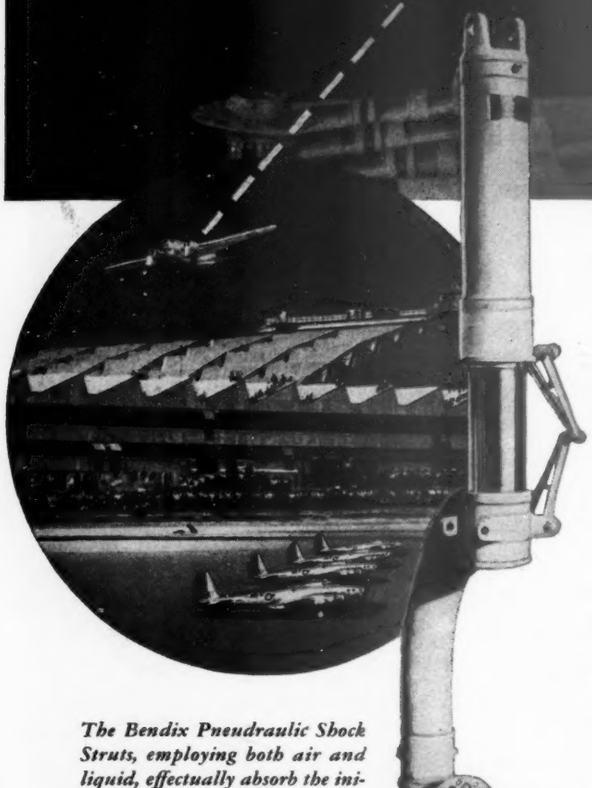
» THIS "N.A.C.A." FOR ECONOMIC RESEARCH can probably best serve the public interest if it is established as a non-partisan, independent, scientific organization, rather than directly as a dependent of the industry, or as a unit of Government. Only by independent status can the research findings avoid being discounted as self-serving, prejudiced and partial; or eliminate unavoidable Government interdepartmental problems of jurisdiction and authority, maintain the necessary scientific detachment, and carry the emphasis with policy-making officials in Government and Congress they deserve. A relatively small amount invested in economic fact-finding and planning now may mean the difference of hundreds of millions of dollars in the industry's future market. At this time, when a dollar invested in research may represent a net expenditure of only some 20 or 30 cents, leaders in our industry cannot afford to overlook the urgent necessity for conducting a comprehensive economic research.

The details of such a program were recently outlined by J. Parker Van Zandt, Consultant to the Civil Aeronautics Board, in a speech entitled: "Aviation's Unfinished Business."

» WE KNEW the pilot training program was really making strides but our eyes have been opened by a letter from a friend who took his family for a vacation trip up into the High Sierras of California. Seems he camped at the 9,000 ft. level, far beyond the reach of telephone and newspaper headlines, on the shores of a beautiful mountain lake teeming with rainbow trout. On his first attempt with rod and reel he was just about to hook a big one when a Stearman training plane came zooming down within a few feet of him. A little investigation disclosed the fact that an Army Air Corps training camp was located just across the lake. Flying was being done from a runway down on a plateau at an elevation of 6,000 ft. For the rest of his vacation our friend reports seeing more planes than fish.

Maguire is learning Russian so he can put the right nameplates on the airplanes that Harry Hopkins promised Stalin.





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The picture above, showing a stage in the assembly of a massive pneudraulic shock strut for a large bombing plane, typifies the care which *must* be exercised in building these vital units. Precision-turned, bored, faced, ground and fitted, the many peculiarly contoured parts of these famous Bendix Struts demand unique production methods... and these must vary with each size and type of strut.

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BENDIX LANDING GEAR EQUIPMENT

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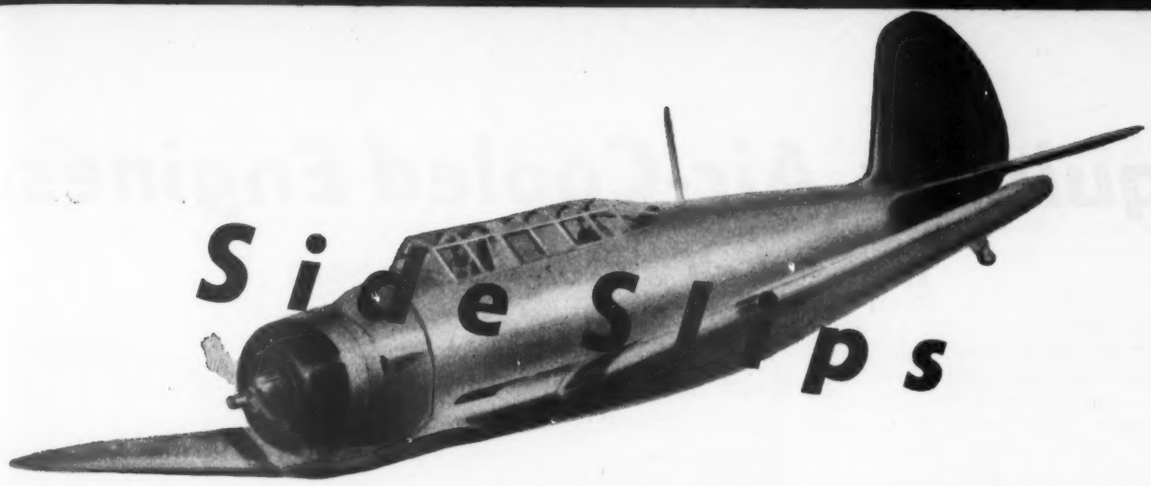
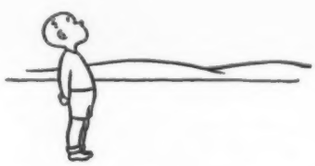


Side Slips

» THE OTHER DAY a student at Randolph Field, fellow named Ross W. Marmack, was doing maneuvers in a Link trainer, when the operator put him into an imitation spin. Mr. Warmack wrestled the rotating robot for some time, according to the Randolph publicity man, when finally the realism of it all became too much for him, and he flung up the hood, leaped out and reached for his rip cord. Everybody laughed, and the tyro explained that he had thought it was time to bail out. Now listen, Randolph, that's pretty good. But wait till one of your aerial jackanapes gets into a real spin and



thinks he's in a Link trainer and just sits there. Then you *will* have something for the newspapers.

» THE EXPERTS TELL US that every new method of military attack is invariably followed by a new means of resistance. But they forget carrier pigeons. Somebody thought of transmitting military intelligence by pigion several thousand years ago, but the warriers, with all their guns, poison gas, airplanes, artificial fog and flame throwers still can't stop a little squab with a vital five-line message in a capsule on his leg.

The War Department announced the other day that "General Mauborgne," a pigeon belonging to the Signal Corps, has established an all-time record by flying a 600-mile course between Erie, Kansas, and San Antonio, Texas, in 13 hours, 59 minutes, and 37 seconds. Several years back the Army all but abandoned carrier birds as a means of communication, but not quite. Now they're back again. Radio transmission can be jammed, or its source can be located by triangulation, but you can't jam or triangulate a pigeon.

You've read about Cher Ami, the bird that saved the Lost Battalion in the World War, even though badly wounded. But usually any number of pigeons can fly safely through a hail of bullets. Seldom are they seen, never at night, and there's no skeet shooter around to wing them anyway. In 1918 the Germans torpedoed a boat, which released a pigeon just as it sank. They turned all their artillery on the bird, but it got away, and the survivors were rescued. Your pigeon is the oldest and most reliable of all aircraft.

P. S. We just now heard that our War Department has falcons, which it turns loose to catch the enemy's pigeons. This would spoil our story, except that the WD claims it has the world's only night-flying squabs, and falcons can't do business at night, which again makes our enemy defenseless against pigeons.

» TWENTY-THREE YEARS AGO, Mather Field, 11 miles East of Sacramento, was noisy with OX-5 motors and the moan of clothesline wire as the Jennies came in, with cadets in white hatbands sparking their girls on Sunday, with bold talk of diving a Spad and a Lewis machine gun on the Kaiser unter den linden.

Then silence came to Mather Field for a few years, until the Post Office Department's Liberty-motored De Havilands, bought from the Army and flown by borrowed Army pilots, landed there on their transcontinental mail trips. Then came the Boeing 40s, with their new air-cooled engines, flown by the same pilots: Vance, Huking, Winslow, Lewis, Little, Sharpnack, still wearing goggles, and always wondering whether a panicky passenger, with nothing to stop him, might some day open the door and jump out of the two-seat cabin.

We stopped once and poked around while waiting for the Post Office mail truck. We distinctly heard the ghost of Lt. Carl Mather pass through a creaking door. He was killed in a formation collision at Ellington Field, Texas, in 1918. We thought of all the gallant second lieutenants with wings, who had died in Europe or had lived and got bald heads and children and mortgages on their six room houses. We thought of Major Reuben Fleet and Major Delos Emmons and Major D. H. Crissy. The wind howled and it was the lonesomest moment of our life.

Now the young flyers are there again, and the new majors, and new planes, all fixing to go after a new guy unter den linden. No doubt they will hang his hide on the fence and then the weeds will grow for 23 more years.

» ". . . So I SLAPPED THE COAL to that lead and zinc mine and reefed back at three g's but it blubbered out in a spit curl like a box car with a built-in headwind"—this from Randolph Field.

The release goes on to tell what this callow slang means but it doesn't matter. It reminds us of the time we got up on the bridge of an ocean liner, all agog to hear the master give orders in seadog jargon. But he simply said, "Take off the bow line." Then he looked out into the harbor and said, "Both engines slow ahead, please." We were terribly disappointed, at the time. But we've never yet seen a real veteran of the sea or air who affected a lingo.

We had two or three of those vernacular experts in *our* squadron. One of them was called "Whitey." This lad, when he had been in the air 20 or 30 hr., wrote a pip of a letter to his home town newspaper. A copy of the paper was mailed to him, and we got hold of it. He told how he could fly through a hangar, and out-side loop, and blow the hats off of people in hayfields. You

can just imagine what a life he had. Whitey was finally discharged. He kept circling right in left-hand traffic.

Liquid or Air-Cooled Engines?

We need all we can get of both

By Major General George H. Brett,
Chief of the Army Air Corps

There has been much talk about the so-called controversy between liquid and air-cooled engine types. In the accompanying article, the Chief of the Air Corps shows why large quantities of both are needed in a properly balanced air force.

General Brett

PROS and cons of air cooling as compared with liquid cooling of aircraft make fascinating subject matter for writers and conversationalists. The merits and shortcomings of the two types, boiled down to their fundamentals, are simple physics with which most any motor-minded layman can play around indefinitely.

The history of the two engine types in this country is almost romantically interesting. No one can be blamed for discussing the subject. Nearly all aviation enthusiasts discuss it, the technical and lay news-men do it as do also Air Corps officers, pilots and mechanics. In fact, such intense interest in our aviation is a healthy symptom of air-mindedness.

It is not to belittle those who discuss it to say the fundamentals of air-cooling vs. liquid cooling are simple enough to be debated by laymen. A few years ago only a fraction of our population had heard of this controversy, let alone any of its details. Today, boys, businessmen, and thousands of air trainees are able to talk intelligently and to understand this, and many other phases of defense aviation.

It is not for a minute suggested that anybody stop talking or writing about it. But it is believed that the interests of the country would be served if they would cease regarding it as a controversy, in which the Army must decide on one engine or the other. They might, rather, discuss the application of both engines to air defense, as, in their present state of development, the air-cooled engine is best for one kind of job, and the liquid-cooled engine is best for another kind of job.

The frontal area of the fuselage presents a given amount of resistance, depending on its size. Obviously there is comparatively little advantage in putting a slender streamlined engine on the nose of a big airplane. An air-cooled engine scientifically cowled and having frontal area not greater than that of the fuselage, generally speaking, will add very little to the airplane's total drag. But a big air-cooled engine on the nose of a slender plane ordinarily adds a great deal to the plane's total drag. The point is that slender, streamlined engines, of the liquid-cooled type, should be and are used on small fighter craft.

Recently, fighter airplanes have achieved great speed with high horsepower air-cooled engines. These engines have been cowled into the planes in a way that cuts their drag to new minimums. It is possible that this streamlining of radial engines can be improved still further, and it goes without saying that the Army Air Forces will take full advantage of any and all such developments.

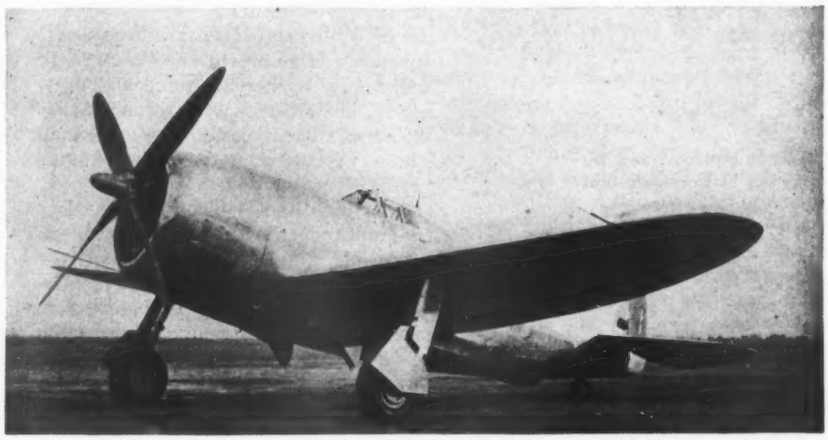
The impression has been created that the Air Force is concentrating on liquid-cooled engines and ignoring air-cooled engines. This is not the case. Air-cooled engines are in all of our medium and heavy bombers, in training planes, and in pursuit ships.

The liquid-cooled engine most generally in use at present is the Allison. It is used in the Lockheed twin-engine P-38, the Bell P-39, and in the Curtiss P-40 series. The Republic P-47 is equipped with the Pratt & Whitney 2,000 hp. air-cooled engine, and the P-43 with the 1,200 hp. model.

Before long the Rolls Royce Merlin liquid-cooled engine, which is now nearing production, will be ready for installation in pursuit 'planes. The Allison now in use is 1,150 hp.; a 1,350 hp. model has been accepted, and various experimental designs are being stepped up to ratings as high as 2,000 hp. The Rolls Royce, which is being built by Packard, is 1,300 hp., and there will be higher hp. ratings later. There are several other types of liquid-cooled engines in development by different manufacturers in cooperation with the Air Force.

Precautions are being taken to prevent being caught short, whatever may be the developments of the European war-makers. Ever since the World War, all of Europe has kept exclusively to liquid-cooled power plants for their fighter planes. It is not for us to say

1700 hp. Wright Cyclones were chosen for Britain's newest dive bomber, the Vultee Vengeance, shown above. Great things are expected from this powerful slugger. Wright has engines of over 2,000 hp. in production for other airplanes.



Demonstrating what can be done with radial engines is this Republic P-47 Thunderbolt. The engine is a 2,000 hp. double-row, Pratt & Whitney air-cooled Wasp of 18 cylinders. It is a fast, high-flying, powerfully armed combat ship.

whether their theory is right or wrong. It is our duty to observe what results they get and to see that ours are better. The public welfare must not rest on theories only of cooling airplane engines.

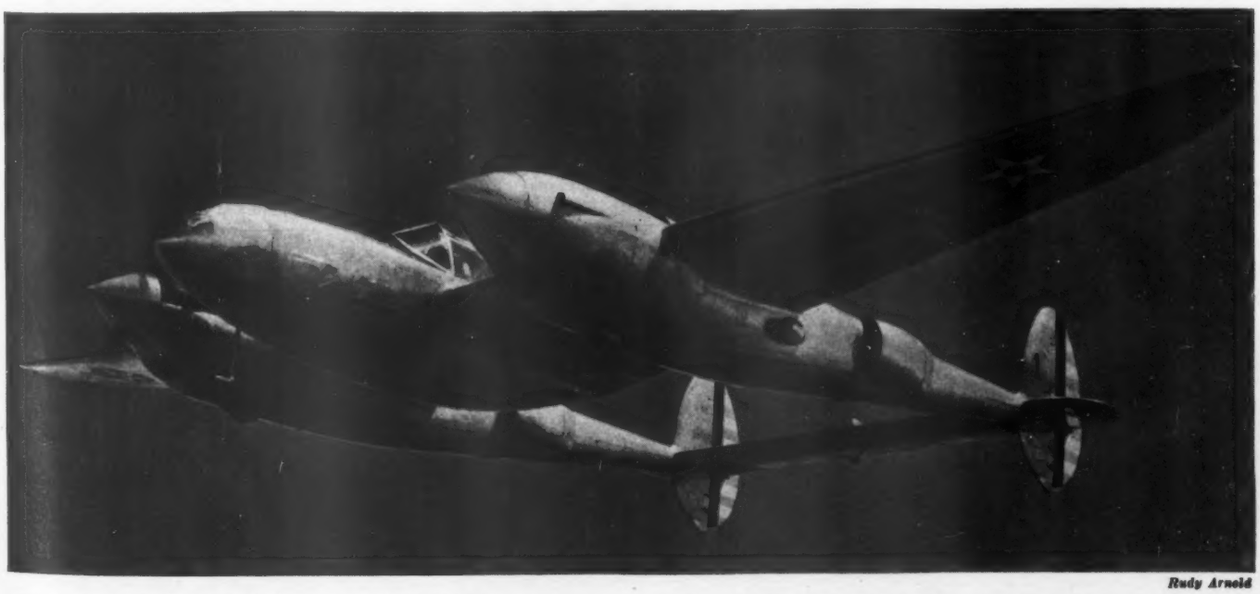
American technicians are to be praised for the progress they have made with liquid-cooled power. Europe has been working at liquid-cooling for 25 years, and yet, already America is sending to Britain pursuit planes with liquid-cooled power plants. In the liquid-cooled field, Europe today has in actual service engines having some two hundred horsepower above American engines. In a few months from now American engines will match any liquid-cooled power plant in use in Europe.

In writing or speaking on this question, it should always be remembered that pursuit attack is only a part of air combat. Otherwise, the liquid-cooling project will be over-emphasized. It is true that fighter planes are tremendously important, but bombers, at times, are needed more than pursuits.

The United States leads the world in air-cooled engines, in horsepower, in reliability, and in durability. The Army, the Navy, the airlines, the aircraft industry as a whole, and the National Advisory Committee are all responsible for this achievement.

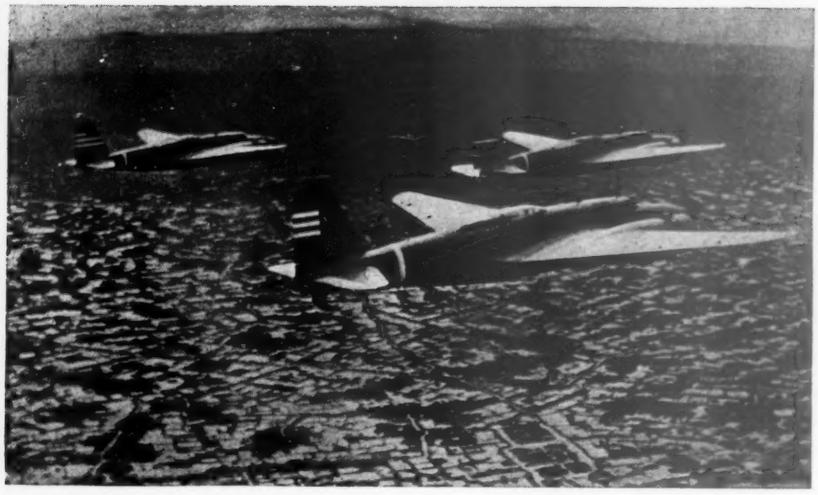
The United States also has and needs good liquid-cooled motors.

The Army is applying both types of engines where they will be most effective and is taking maximum advantage of production facilities by buying both types as fast as they can be produced.



Rudy Arnold

This is the Lockheed P-38, known as the "Lightning." Its two liquid-cooled Allison engines give it great speed. This ship has not yet been tested under actual combat conditions but it should be a powerful opponent for any combat plane.



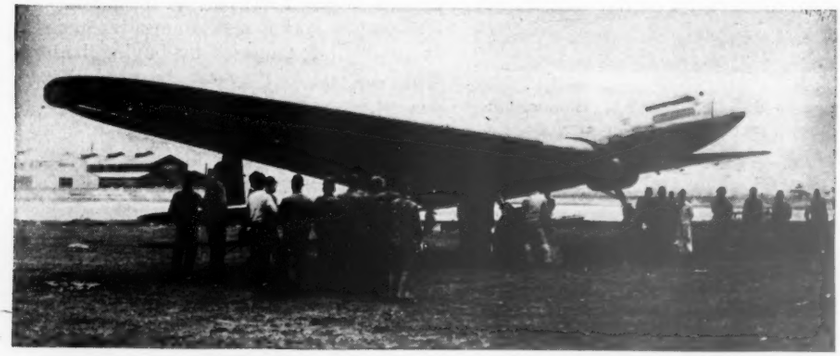
JAPANESE

In view of the significance of accurate appraisal of Japanese air

By Lucien Zacharoff,

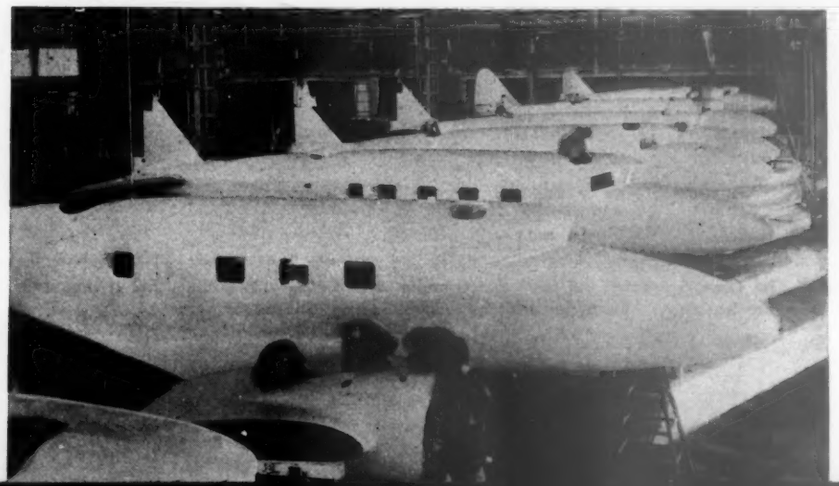
Nakajima Type 19 bombers used by the Japanese army. Top speed is reported to be about 217 m.p.h.

A Kawasaki biplane, used by the army for both fighting and bombing.



Japanese mechanics gathered around a large, single-engined, low-wing monoplane. Ship is large for only one engine.

This factory is turning out Nakajima transports.* This firm also is licensed to build Douglas DC-2 transports.



A NEW CRISIS is approaching in world affairs. This time Japan is strutting to the fore in the international arena. How long will she hold the stage? That will be determined in a large measure by the strength and quality of her air force and manpower, her strategy of air combat, her industrial background and potential. These all-important factors are surveyed herewith, with a view to ascertaining how and if Tokyo's air power can influence the balance of power in a possible Battle of the Pacific.

Japanese military aviation is administered by the Military Flying Section of the War Department. The Section concerns itself with instruction, training and other matters pertaining to the air force. Also at Tokyo are the headquarters of the Military Air Forces and the Military Aerial Supply Depot which has branches in Korea, Formosa and other outposts of the empire. The Military Flying School teaches flying and engineering, reconnaissance, fighting, bombing and pilotage.

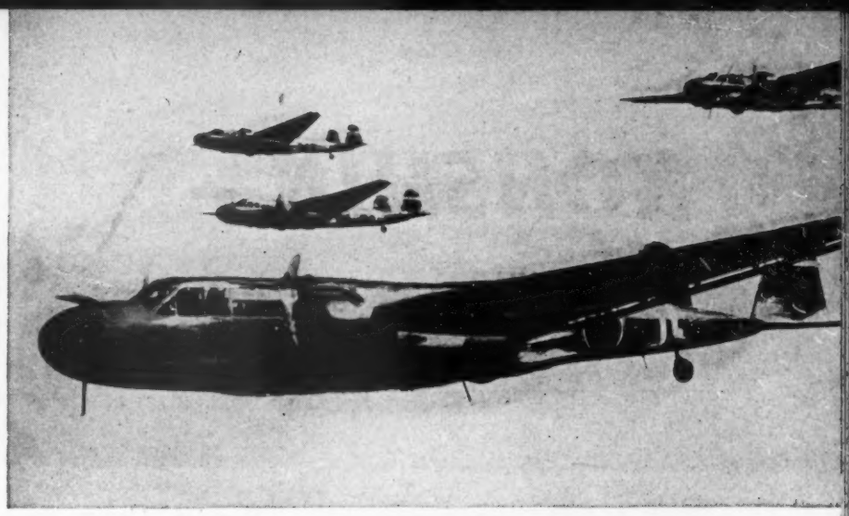
It sounds incredible that Japan's seven army and navy air-training schools are graduating a total of much fewer than 1,000 pilots a year! The quality of their education may be appraised by the fact, admitted by Tokyo censors, that even in peacetime, the Japanese military and commercial fliers have the highest accident rate in the world.

The research establishment, which is servicing both civil and military aviation, is the *Tokyo Teikoku Daigaku Doku Kenkyujo,* which may be approximately translated as the Institute of Aeronautical Research. Attached to the Imperial University of Tokyo, it is situated at Komaba, near the capital. Presided over by Dr. K. Wada, it delves into the problems of aerodynamics, aeronautical psychology, aircraft, aero engines, chemistry, instruments, materials, metallurgy and general affairs. It is equipped with a wind tunnel, library, drawing and workshops.

AIR POWER

aviation activity in the Pacific, this power is particularly timely

Associate Editor, Aircraft Publications



The Navy uses these sleek Mitsubishi Soyokaze bombers. Cruising speed is 161 m.p.h. with two 800 hp. Kinsei engines.

In recent years there has been no susbtantial change in the composition of Japan's air regiments, which are variously reported to number from 14 to 18 and which are garrisoned through the several prefectures. The Balloon Regiment is situated in the Chiba Prefecture, while Independent Air Squadrons are regularly stationed in Manchuria.

Leading military airdromes are found at Ainei, Akenohara, Hamamatsu, Heijo, Heitogai, Kagamigahara, Kagi, Kumagaya, Osaka, Tachiarai, Tachikawa, Tokorazawa, Shimoshizu, Uyeda and Yokkaichi.

Tokyo is the home of the Headquarters of the Naval Air Service, with Naval Air Stations distributed throughout the islands and outlying possessions. The Aircraft Battle Force is divided into three fleets, each under an Air Commander who ordinarily has the rank of Rear Admiral.

The Imperial Navy incorporates Aircraft Carriers Hosho, Akagi, Kaga, Rujyo, Soryu, Hiryu, which furnish bases to a total of less than 250 airplanes. The Navy Seaplane Transporters are the Kamoi, Notoro and Chitose; these have catapults for launching. Perhaps 14 battleships have been fitted to carry from two to four aircraft each. One or more seaplanes may be found aboard each of the 43 cruisers, scouting being their function.

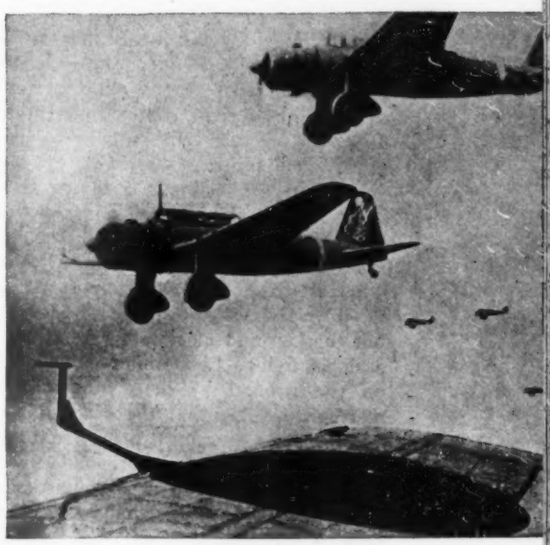
It may be seen from the foregoing description of the structure and administration of the aerial combat forces that there is no independent air force in Japan and that aviation is divided between the army and the navy.

These two air arms between them can muster a maximum first-line strength of less than 5,000 machines, according to informed students, though other, equally dependable commentators believe that, all told, Japan has no more than 3,000 workable military aircraft of all types, from trainers to front-line fighters. Even figures of the experts who advise that we do not underestimate Japanese air strength, do not sound too alarming. Among these the best-posted is probably Charles Healy Day, veteran airplane designer, one-time round-the-world flier and for the past six years technical counsellor to the Chinese Government on aircraft production; now back in the United States, he informs us that the Japanese have 900 first-line planes in China and 4,500 such warplanes altogether.

The pilots available to man those planes probably number 5,000. Before analyzing the reasons for this paucity of flying equipment and personnel, a look at the prevailing military aircraft types is in order. Greater secrecy enshrouds these in Japan than in any other country; truly Oriental perseverance is required of an American or European reporter in gathering such data; after his exertions are over, the details are still incomplete, though it is known that, by and large, Japanese combat planes are under-gunned.

American aviation circles don't have to take a second look at the leading Japanese military aircraft types to decide that most of them are obsolete or obsolescent. That Japan more or less has had her way in the air over China is principally due to the fact that no

(*Turn to page* 146)



Army combat ships like these have become familiar sights over parts of China in recent years.

Commercial version of the Mitsubishi Soyokaze which was used in Japan's "good will" flight around the world.

All photographs from Japanese American News Photos

KONSHIN—
Emperor of the Campo

How Barreiras Airport was carved from the heart of the Brazilian jungle

By George H. Copeland
Travel Editor, The New York Times

BEFORE 1929 the Argentine was 18 days from the United States, by the fastest boat. In that year America's long-range aviation roared into action, and the time was cut in half, to nine days, 7,000 miles. Today you can get there in three and a half flying days from Miami, stopping en route at Rio de Janeiro, only three days away.

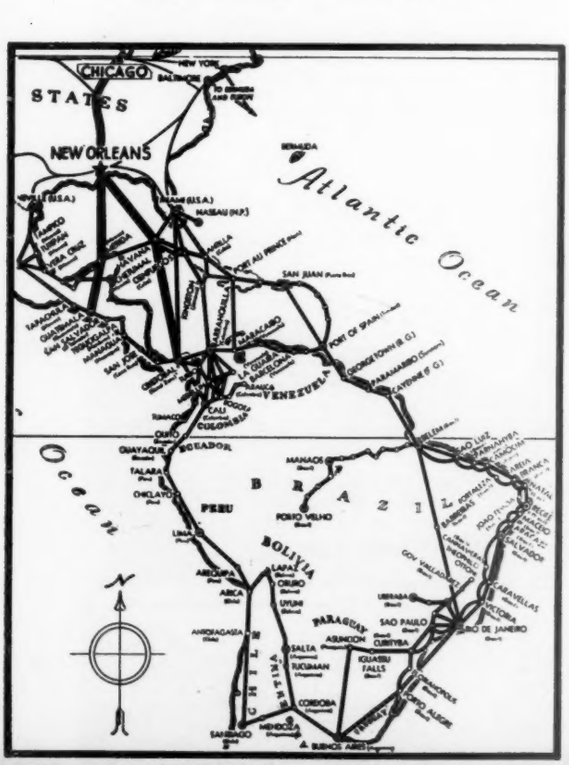
Most of this schedule-cutting was done mechanically, over blue-prints, in wind tunnels and testing laboratories, but the last and most important slice—a day's flying, 1,000 miles—was made on the ground by the sweat of one man's brow, right at the End of Nowhere, with the most primitive tools, the most unskilled labor, and under living and working circumstances which made success impossible—except to one man.

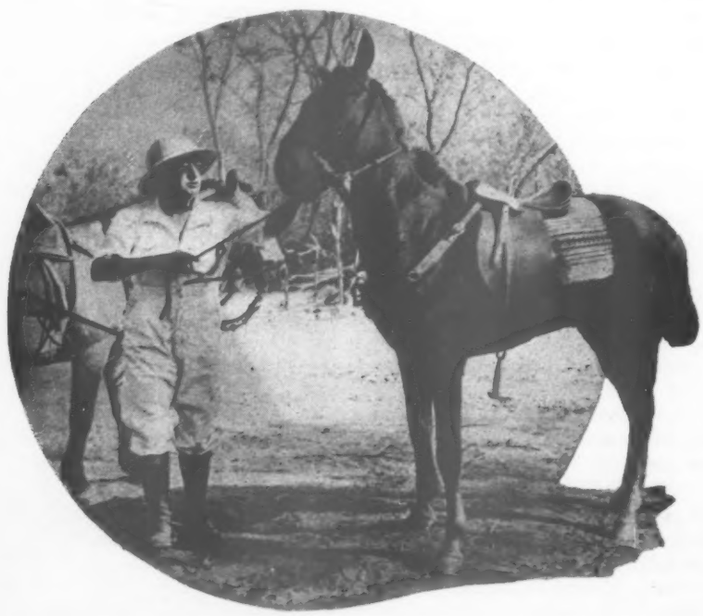
I saw this man, George Sybin Konshin, and the amazing job he had done. I found him ruling a tiny and primitive American empire on the Brazilian campo, putting the finishing touches on Barreiras Airport, one of the world's unique and important landing-fields. He had built it almost with his own hands. I talked with him in his little "office", a thatched hut of palm rushes and banana leaves supported by bamboo poles, an office nearly 1,000 miles from the nearest telephone, and 35 days by surface route to the nearest seaport—35 tough, tortuous days by trail, dug-out and paddle-wheeler. Here he reigns over a lofty kingdom, a smiling, stocky man in pith helmet, boots and dungarees. He has grown to be a legend over half of Brazil, and is named by the natives "The Man on a Machine."

Much of today's pioneering is done by the scientist and engineer. Your new automobile, which jumps up to 60 in no time at all and which needs no gear-shifts, is the product of somebody's laboratory. When we cut an hour off the flying-time between New York and Los Angeles, it's because some engineer has made new designs on a blue-print. But Konshin had no laboratory or even a machine-shop. All he had was sheer courage, resourcefulness and dogged persistence. His pioneering was done the hard way. He had to find and train his own labor, dig for drinking water, make his own bricks, blast through solid rock—and he had to start at scratch in a desolate, sun-baked land.

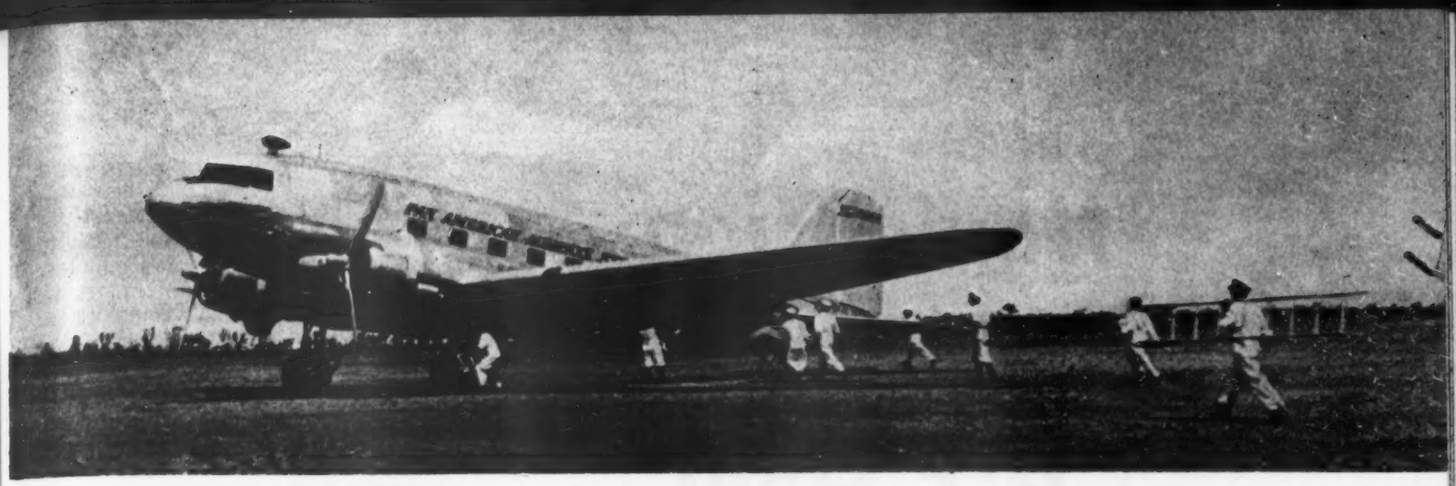
We have seen frontiers pushed back in our own country, but we don't realize that in South America, now only a day away by plane, there is untouched wealth, untrodden trails, undiscovered territory awaiting development by daring and ingenious men. Today planes fly over thousands of miles of its mountains and jungles but, first, airports must be carved out by men on the ground, often in fever-ridden spots menaced by hostile Indians, animals and hordes of insects.

The construction of Barreiras Airport was stark drama. It cut a thousand miles off the skyway from America to Rio and the riches of the Argentine, and opened up a million acres in a land of gold and diamonds, of nickel, oil and manganese. And it brought New York and Washington closer to those



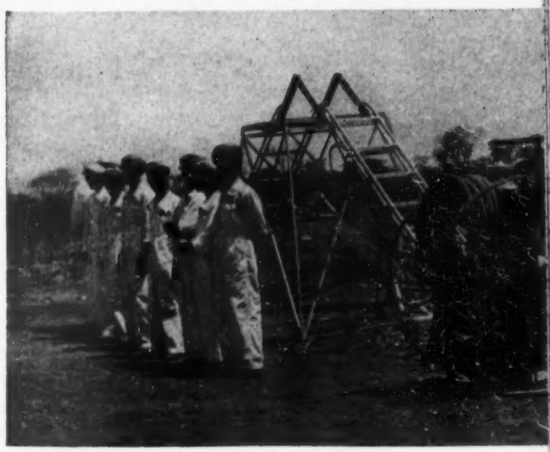


George Konshin—the man who built Barreiras Airport, which is shown on the map at the left.



The landing field at Barreiras, high atop a great plateau.

Left: The road up to the airport was carved inch by inch from a primitive jungle.



Right: The P.A.A. maintenance crew that handles ships enroute.

lands than are Berlin and Rome—an achievement vital in these days of wars and alarms.

Take a look at the map of Brazil. If you fly straight down from Belém (Pará) on the Amazon to Rio you avoid going around the "Hump" and save 1,000 miles and a day's flying. But you've got to break up that 1,546-mile trip, for refueling. Where to land? Barreiras is right in the middle, strategically an ideal spot for Brazil's growing military aviation and for America's spreading wings of trade and travel. Here, hell or high water, must be a first-class airport.

Let's paint the setting. In these highly advanced days it seems incredible but, until the coming of the airplane, fewer than a handful of white men had ever crossed the wide belt of Brazil's dark interior. Any map of South America will show great blank spaces from Matto Grosso to the Amazon; scarcely a dot will show between the Rio São Francisco and the Tocantins. Through this "blank" the Rio "cut-off" is swung, with Konshin's airport in the center.

I flew over fantastic country on my way from Belém to Barreiras. At the north is a 300-mile fringe of Amazonian jungle-matted trees and vines so densely packed that it looks like a vast field of broccoli, so thick that sunlight never penetrates to the earth below. It is patterned with winding strips of jungle-black water, whose courses are like ribbons dropped from a balcony, which flash like lightning when the sun strikes them. Then comes another 400 miles of desert-like country—a medley of sand, shrubs, arroyos, strangely colored, carved "grand canyons" and here and there a green-bordered river valley.

Right in the middle of this vast, virgin area, where rugged tableland follows winding canyon as in our own Utah or Arizona, rises "The Barrier", the great mesa of Barreiras, shooting up from a sheer precipice 1,000 feet above the surrounding country. Its surface lies perfectly flat, visible for miles through the clear, sun-drenched air of the campo. Not an obstruction within 500 miles. From our plane we could see it at a great distance. Details appeared as we got closer; long white runways, radio tower, a few brick buildings, a line of brown huts. Currents of heated air sweeping up from the sides of the mesa gave us a good bumping as we circled for a landing.

Here I talked with George Konshin, star actor in the drama of Barreiras, heard his lines, and saw his spectacular stage-sets. For other acts and scenes, I had to go to those who had played minor roles in planning this production —fliers, mechanics, desk men in Belém, Barreiras and Rio.

(Turn to page 170)

The station at Barreiras in the process of construction, with the three radio masts clearly marked.

Konshin and his wife live in the white tent in the center. Balance of the personnel live in the thatched houses.

Navigation With the D/F Loop

Principles of the Radio Direction Finding Loop

By C. H. McIntosh,

Instructor in Charge, Chicago Pilot Training School, American Airlines, Inc.

RADIO navigation as applied to aircraft may be defined in simple terms as the art of conducting the flight of an aircraft from one position to another over the earth's surface by the use of radio signals for directional aid.

Since it is directional aid (used in the sense of providing directional indication in a plane parallel to the earth's surface) that becomes the prerequisite for navigation, this presumes either that the radio energy radiated from the transmitting station be directional in character or that the receiver picking it up do so in a manner to provide the required directional sense. Both of these basic principles are used.

Within the continental United States, of course, as well as Canada and Alaska, the primary method of providing navigational aid for aircraft is by means of the familiar network of radio range stations. This exemplifies the practical adaptation of the directional transmitter. Radio ranges are specially designed ground stations sending out coded and directionally controlled signals in such a manner that four fixed radio beams are available for aircraft guidance along the airways. To use them, the aircraft radio equipment need consist only of a conventional receiver covering the 200-400 kilocycle frequency band.

While undoubtedly the radio range network as maintained in the United States represents the finest system of radio aids for aircraft navigation existing today, the method itself is not ideal. From the purely navigational standpoint, the idea is somewhat of a compromise. Actually, when conventional receiving apparatus is used in the aircraft, a range station provides a pilot only four fixed courses to or from the station. The directions of these courses are not governed by the choice of the pilot, but are determined and fixed in order to mark out particular airways. As a result direct line navigation for any considerable distance is usually impractical inasmuch as the beam alignments of successive ranges seldom provide a direct airway. Then, too, in practice, flying the ranges with conventional receiving equipment, is frequently made difficult and uncertain for even an experienced pilot. Poor reception combined with any of the common eccentricities of the ranges easily may cause a pilot to become lost. Once this happens, orientation can become a complicated and time-consuming problem.*

The alternate principle for radio navigation is to use receiving apparatus of directional sensing character. Such apparatus is commonly termed a radio direction finder or D/F loop receiver. With such equipment a directional bearing can be easily obtained on any type of radio transmitter within the sensitivity and frequency ranges of the receiver.

Practical adaptation of the direction finder principle follows two fundamental systems.

In one system the direction finders are strategically located on the ground so that directional indications, or radio bearings, may be taken on aircraft transmitters. Two or more of these bearings taken simultaneously by widely separated ground direction finders (or at intervals by one station and properly co-ordinated) serve to establish the airplane's position. They can be plotted on the ground and the resultant position radioed to the pilot or the bearings can be furnished to the pilot for his own plot of position.

Marine navigators have long used such a system of direction finding provided by a federal network of stations located along the seacoasts of the United States and on the Great Lakes. In the aircraft field, Pan American Airways has employed a similar system extensively for trans-oceanic routes.

The reverse method of carrying the direction finder in the airplane itself has found much more widespread use than the method just described. With this arrangement, the pilot or navigator is able to take his own bearings on any ground stations within the capabilities of the receiver and work out his own navigational problems with a mini-

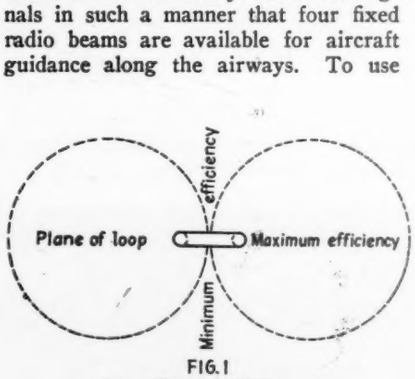
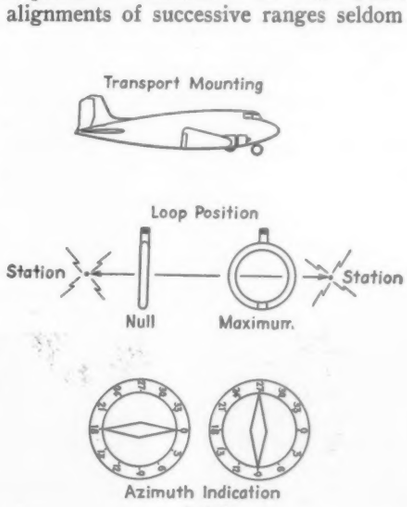


FIG. 1
Loop Signal Field Strength



Azimuth Indication
FIG. 2

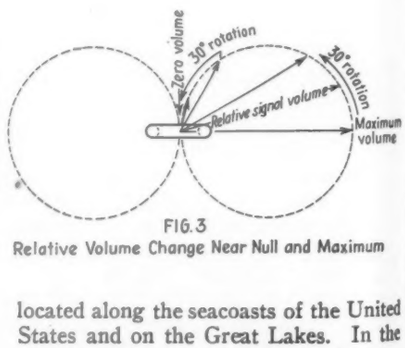


FIG. 3
Relative Volume Change Near Null and Maximum

* Note: For a more complete description of radio range theory and operation suggested reading is "Radio Range Flying" by the author or any modern air navigation text.

mum amount of dependence on ground personnel. This system of aircraft direction finding has long been the primary method of radio navigation in portions of the world where a radio range or ground direction finding network does not exist.

Even though radio navigation in the United States is still fundamentally governed by the radio ranges, aircraft direction finding equipment is becoming almost universal. It has, in fact, been compulsory for scheduled airline operation since 1937. Without question, radio direction finding from aircraft provides an ideal system to be used in conjunction with, and to supplement, radio range technique. The disadvantages of each method used alone are almost entirely eliminated when used together.

Antennas

Strictly speaking, the application of the term directional to either a radio

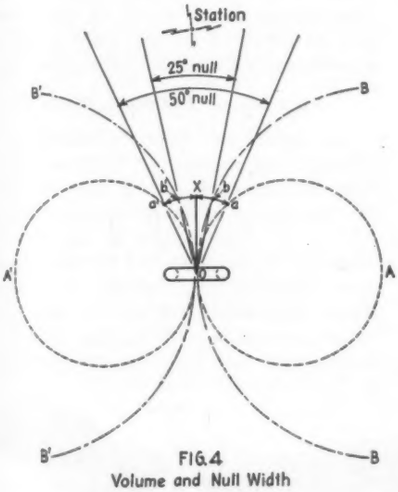


FIG. 4
Volume and Null Width

transmitter or receiver is incorrect. It is neither the transmitter or the receiver which furnishes directional character to the radio energy. This is purely a function of the antenna from which the energy is either transmitted or on which it is received.

Conventional antennas either for transmission or reception can be considered as a whole non-directional, that is, they either transmit or receive radio energy with approximately the same intensity in all directions; or, if they do possess any directional character, it is in such small degree as to render them extremely inefficient in a directional sense. Among these non-directional antennas are the single, vertical mast so common to commercial broadcasting stations, the horizontal multi-wire flat top used on ships and certain shore stations, and the usual single straight wire household receiving antenna.

It has long been known, however, that a closed loop or coil of wire makes a radio antenna that is highly directional for both transmission and reception. This is not surprising since the action of a coil used as a radio antenna conforms in all respects to the same electrical principles governing the behavior of any closed coil when influenced by an electrical field of force. Dispensing with all discussion of electrical theory (which may be found in any elementary physics text book), such a loop antenna exhibits maximum efficiency for either transmission or reception in line with the plane of the loop; and minimum efficiency in a direction perpendicular to the plane of the loop. Refer to Fig. 1.

As applied in a practical manner for an aircraft receiving antenna, the loop usually consists of several turns of insulated wire wound as a narrow coil approximately 12 to 18 in. in diameter. In addition, the coil is customarily enclosed within a duralumin tube or a streamlined housing. While such an enclosure serves to protect the loop windings, it is primarily designed to act as an electrostatic shield for reduction of precipitation or atmospheric static interference.

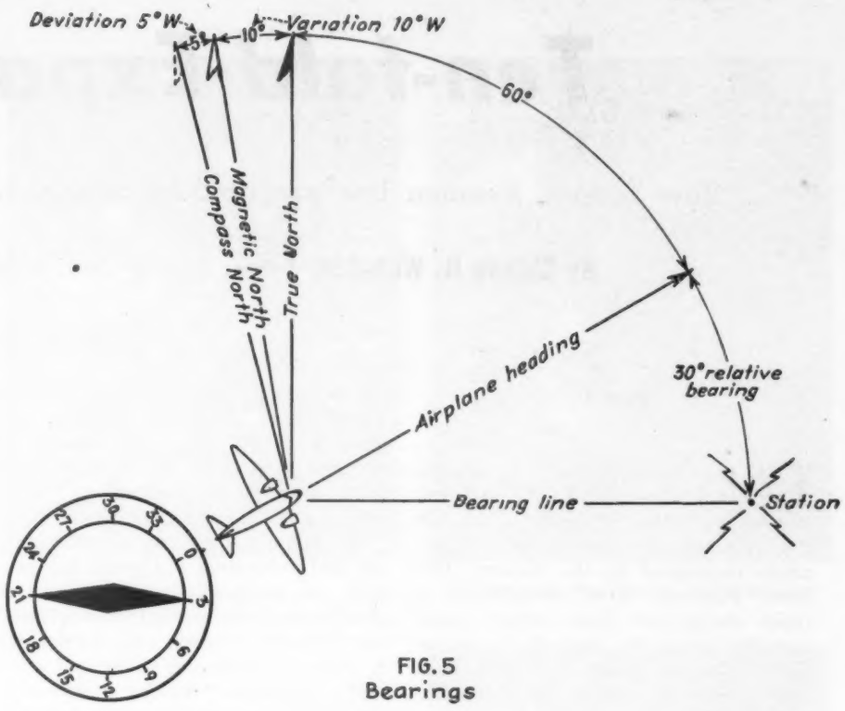


FIG. 5
Bearings

The Aircraft Aural Null Loop

Of the many different types of aircraft direction finding equipment which have been developed around the directional properties of the loop antenna, the most simple and fundamental is the so-called aural null direction finding and anti-static loop. For this reason, and since a clear understanding of aural null loop operation is necessary for a proper study of other types, subsequent discussion will stress this type equipment.

As the term implies, the aural null loop provides the pilot or navigator with aural rather than visual indications of direction. A shielded loop of the type described and capable of being rotated through 360 deg. is used (fixed position loops are occasionally used but are much more limited in operation than the rotatable type). Within the cockpit is a crank and azimuth scale; the one to provide means of rotating the loop, and the other to indicate its position relative to the airplane's longitudinal axis.

Preferred mounting of the loop is on the underside of the fuselage near the nose. This is particularly true for large metal covered airplanes since in this location the structure interferes least objectionably with the incoming radio energy. Sometimes, however, structural considerations necessitate placement of the loop above the fuselage.

No special receiver is required in place of the conventional range frequency receiver but merely a suitable antenna switch to allow substitution of the loop for the usual straight wire antenna. Occasionally, when a range receiver is used which has not been designed for loop operation, it is necessary to compensate for the reduced signal pick-up of the loop as compared to the conventional antenna. This is done by adding an auxiliary amplifier between the loop and receiver.

(*Turn to page 158*)

Ten-fold Expansion

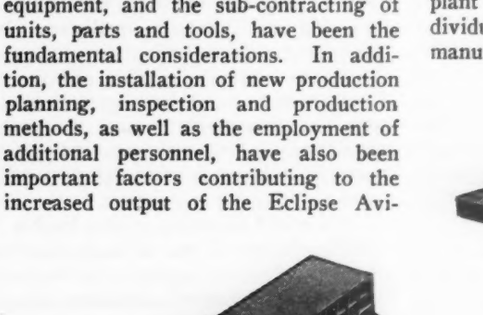
How Eclipse Aviation has prepared for defense by expanding its facilities

By Sidney H. Webster, *Eclipse Aviation Division, Bendix Aviation Corp.*

Part I

THE growing importance of aircraft accessory equipment to the safe and efficient operation of modern aircraft plus the rapidly increasing requirements occasioned by the National Defense Program have necessitated a rapid changeover from former small quantity production methods to an in-line production system, with the result that production output has been increased more than tenfold during the past two years.

To meet the increased demand for aircraft accessory units required by the various commercial and military services, Eclipse Aviation has adopted a complete program for expansion in which decentralization of manufacturing, plant expansion, leasing of additional plants, modernization of plant equipment, and the sub-contracting of units, parts and tools, have been the fundamental considerations. In addition, the installation of new production planning, inspection and production methods, as well as the employment of additional personnel, have also been important factors contributing to the increased output of the Eclipse Aviation Division of Bendix Aviation Corp.



Eclipse Aviation plant at East Orange, N. J.

In planning this expansion of facilities, particular attention has been given to the problem of decentralization due to the fact that certain units vital to the defense program were of exclusive manufacture. Under the present program it will be possible to manufacture any one product at two or more given locations if, in the event of an emergency, such a requirement should arise.

As manufacturers of aircraft starting and generating equipment for more than 20 years, Eclipse Aviation has steadily expanded manufacturing facilities through research and development to embrace numerous additional products including various mechanical, electrical, pneumatic and hydraulic components for aircraft applications. The rapid growth of the aircraft industry during the decade just past plus the development and manufacture of numerous new items of equipment were responsible for the erection of the present new and modern plant at Bendix, N. J.

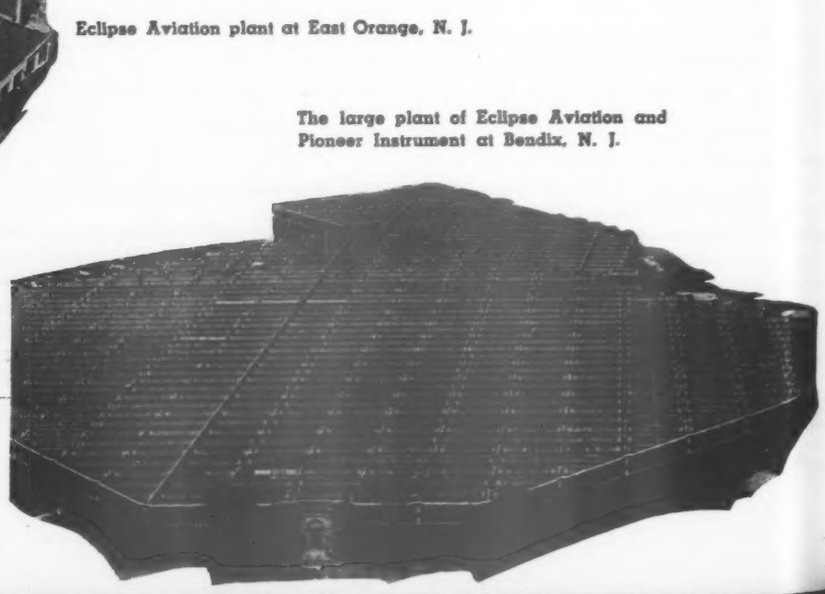
As originally designed, the main plant at Bendix consisted of two individual buildings composed of a main manufacturing plant and power house. The manufacturing plant, although originally designed to cover a total floor space of approximately 328,000 sq. ft. was subsequently enlarged during 1940 to provide a total floor space of approximately 380,000 sq. ft. To provide an adequate and controlled source of aircraft quality non-ferrous sand castings for use in the manufacture of Eclipse aircraft accessory units, a separate foundry building covering approximately 36,000 sq. ft. of space was erected adjacent to the main plant to supplement existing foundry facilities.

Leasing of Additional Plants

In order to meet increased production requirements, facilities were further increased during the past year by the leasing of approximately 100,000 sq. ft. of floor space in the former manufacturing plant of Eclipse Aviation located at East Orange, N. J. With these additional facilities it was then possible to move the complete assembly, production test and special machining

Eclipse and Pioneer leased this factory at Philadelphia.

The large plant of Eclipse Aviation and Pioneer Instrument at Bendix, N. J.



Trimming a sand core for a magnesium generator housing casting.

Pouring aluminum castings at the Eclipse foundry.

Microscopic examination of specimens.

departments to the new space at East Orange, permitting additional space in the main plant at Bendix for installation of production machine tools.

Shortly thereafter it became apparent that the combined facilities of the Bendix plant and the East Orange plant were not adequate to meet the requirements of the National Defense Program, in view of which a plant covering approximately 640,000 sq. ft. of space was leased at Philadelphia for the purpose of manufacturing certain major types of starting equipment as well as certain units manufactured by the Pioneer Instrument Division of Bendix.

As the requirements of the defense program became increasingly great, it became further apparent that additional steps for plant expansion would be required. Faced with this problem, Eclipse had the alternative of obtaining additional manufacturing units through the selection of suitable sub-contracting plants, or expanding existing plants through new construction, entailing the purchase of numerous new machine tools. Due primarily to the shortage of machine tools and the time involved in the construction of new manufacturing facilities, a careful survey of manufacturing facilities not operating at full capacity was made by Eclipse production engineers throughout the various states east of the Mississippi River. After careful consideration it was found that certain manufacturers were properly equipped with machine tools and skilled personnel capable of manufacturing certain specialized items of Eclipse equipment.

In view of the above, the policy of utilizing sub-contractors' plants for the expansion of manufacturing facilities was adopted due to the rapidity with which increased production could be obtained. In line with this policy, sub-contracting plants manufacturing complete units have been set up at various points, including plants at Laconia, N. H.; Rochester, N. Y.; Dayton, O.; and Waukegan, Ill. These plants are now in operation at full capacity at the present time, producing accessory units to Eclipse drawings and specifications under Eclipse supervision.

To further expedite production of units, a study was made of various manufacturing plants not operating at full capacity which were properly equipped to fabricate certain special parts requiring the use of special machine tools, and to whom parts were subsequently sub-contracted.

With this rapid expansion in manufacturing facilities, the problem of furnishing jigs, fixtures, gauges, etc., for manufacturing individual parts required attention. To expedite the furnishing of these tools, the Eclipse Tool Design Department was expanded and special tools and fixtures subsequently manufactured by sub-contractors to Eclipse specifications.

Plant Modernization—Foundry

In order to increase production output of the main plant at Bendix, New Jersey, certain definite steps were taken to speed up the output of specialized departments in order to maintain an in-line production system. The essential factors in this program for increased production were modernization of equipment and improvement of heat treating, inspection and production methods.

Although primarily designed to provide an adequate and controlled source of high strength heat treated alumi-

(Turn to page 166)

Rough turning the front housing for an Eclipse starter.

Checking the internal thread grinding operation.

Detailed descriptions of a "standard airplane" are supplied to a customer, who decides what he wants "as is" and what he wants changed.

Airplane Specification Engineering

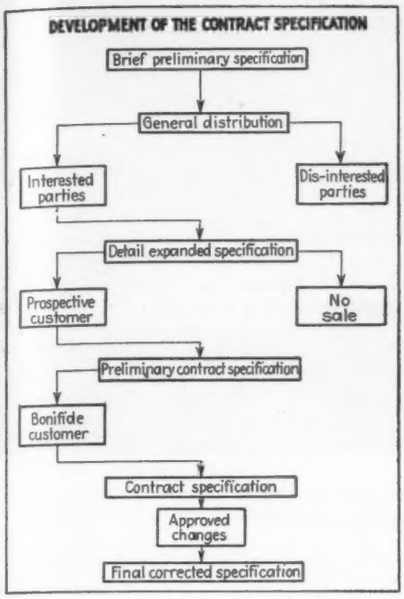
Describing the work of the Specification Staff at Lockheed

By Peter A. Beck, *Specification Staff Engineer* **and Richard H. Robb,** *Assistant, Lockheed Aircraft Corp.*

AIRPLANE specifications are important in any aircraft procurement program, civil or military. In recognition of this fact, Lockheed Aircraft Corp. established a Specification Engineering Group a number of years ago. This policy has two advantages: (1) it relieves the project groups of considerable detail work, and (2) it provides coordination between projects and between engineering and other departments. Although this article deals primarily with the commercial project work done by the Specification Engineering Group at Lockheed, this same unit coordinates all bids on domestic and foreign proposals, both civil and military types. The early history of the now famous Hudson in use by the RAF, centered in this group. Following the first contract the coordination and commitments for all other military types have been carried out in this group insofar as the bid data, specifications, schedules, letters of transmittal, etc., are concerned.

Work of the specification engineering group is concerned primarily with the writing of airplane specifications of two general types. The first of these is simply an airplane specification. The second is called a "Design Directive and Construction Specification," which is for use mainly within the engineering department as a sort of design "Bible."

In addition to preparing data under the above classifications, the specification group acts as a clearing house for general information relating to airplane or airplane parts specification data regarding any Lockheed airplane, and to coordinate all information affecting the specification. For instance, it is an established procedure that engineering information required for the sales department, or any other department, on a specific airplane, be obtained from the engineering department through the specification staff engineer. If we don't have it, it is our job to get it. However, between the airplane specification (Army, Navy, British Air Ministry, Commercial) and the design directive, all or nearly all necessary data are published before they become a problem to the designers. As a general average, 65 individuals in 25 different departments receive copies of specifications and design directives. Our distribution list covers approximately 150 Lockheed personnel. Sales specifications are distributed to outside parties by the hundreds.



Responsibilities and scope of work of the specification engineering group in regard to commercial projects during the course of negotiations for the sale of an airplane include: (1) the contract, (2) the contract price and payment schedule, (3) the airplane specifications. When a prospective customer decides to buy a Lockheed airplane he wants to know, in specific terms, what he is getting. Lockheed, in turn, can't build a satisfactory airplane for the customer unless it is known what the customer requires in all particulars. Therefore, the specification engineering group prepares what is called an "Expanded Airplane Specification," which describes for the customer in considerable detail what Lockheed has to offer, listing alternate engine installations and describing a "standard" airplane. Performance, weight data, interior trim, equipment lists, etc., for all airplane-engine combinations, are listed in these "Expanded" specifications. The customer studies this specification and tells Lockheed what he wants "as is," what he wants changed, and what special equipment, trim, etc. is wanted. Working with these data the specification engineering group prepares a "Contract" specification covering the specific airplane and listing performance and weight guarantees applying to that airplane-engine-interior combination.

"Contract specifications" provide systematic means to permit both buyer and seller to change the details of the airplane by mutual consent. This is necessary because such changes are invariably required. A system for handling changes has been developed by which a list of "Proposed Changes" is submitted to the customer. This shows any changes in weight, cost, performance, delivery, or other pertinent facts, brought about by the physical change to the airplane, and serves to coordinate all effects of any change proposed.

When the last airplane of the contract is delivered all approved changes are incorporated into the specification, which is then issued as "Final Corrected Information" for use by both parties.

A procedure now followed requires that the specification engineering group prepare a specification for every airplane contract. Within the past three years airplane contract specifications have been prepared covering sales in excess of one quarter of a billion dollars without loss due to faulty airplane specifications.

As previously mentioned, this group prepares "Design Directive and Construction Specifications." In an engineering department as large as ours it would be a tremendous problem if we were required to make available to everyone in the department both the contract specifications and the basic specifications for the several airplanes under design. The solution to this is the "Design Directive," which serves to disseminate the necessary data to the people who are concerned with the solution of the particular problem.

The "Design Directive" is amended and revised as necessary due to changes, developments, and improvements as the design progresses. As a specific instance, the March 1940 revision of the Model 44 Design Directive consisted of about 36,000 words on 175 pages containing all detailed instructions by various group leaders, factory executives, etc.

The "Brief" (preliminary) and "Expanded" sales specifications are prepared by first coordinating with the data contained in the applicable "Design Directive" when such a design directive is already in existence for the airplane under consideration. These two forms of data—the specification and the directive—are so closely associated that coordination according to a plan is easily accomplished. Second, in addition to the above, performance and weight data are checked with the aerodynamics and weight control groups. Further data are acquired from personnel and from engineering records and from the model specialist in the engineering specifications group. Naturally, close coordination is required with the project engineer, his group, and all staff engineers. The written data are supplemented by diagrams and

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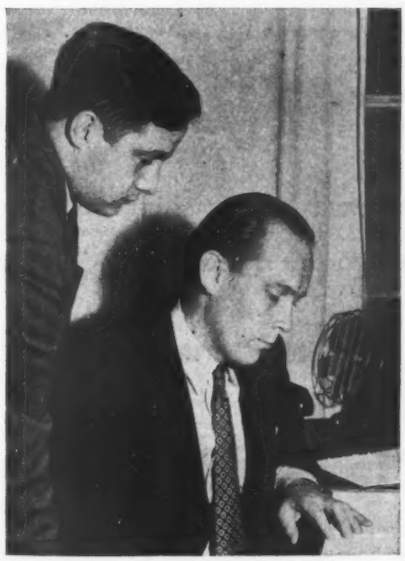
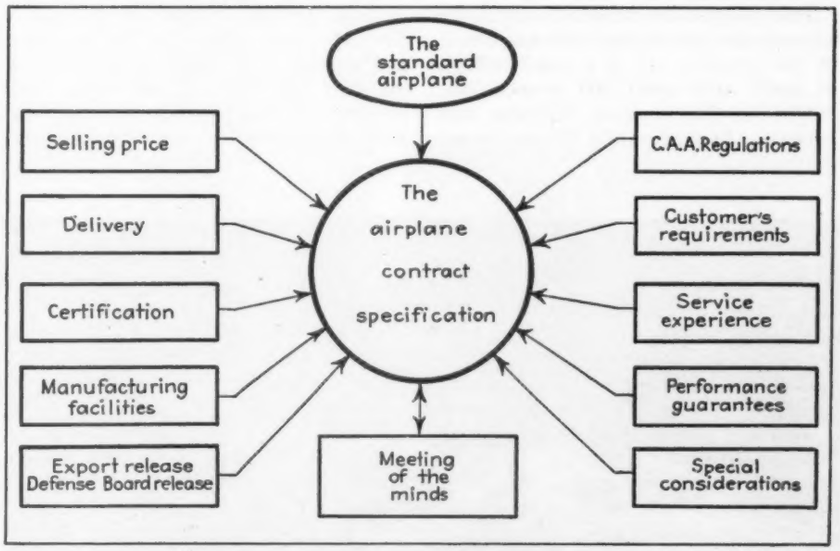


The authors, R. H. Robb (l.), Ass't. and P. A. Beck, Specification Staff Engineer



Factors involved in a contract specification

The highway approach to the administration building is well laid out to handle vehicles transporting arriving and departing passengers as expeditiously as possible.

Washington National Airport

The fine new field at Washington has many new features and is worthy of the name, "National Airport."

By John Groves, *Manager*

THE Washington National Airport has been described as a "model air terminal," an "experimental field," and a "show-place." It is none of these, but rather a modern air terminal built to meet the particular requirements of the Nation's Capital and its environs. It is serving that purpose adequately and efficiently.

Few people who have not visited the airport can comprehend the magnitude of the project. It is a small village in itself with about 900 persons employed in the terminal building and hangars. Approximately 170 employees are engaged in the actual operation of the airport. These are all under Civil Service, employed by the federal government. The remainder are employees of the airlines who maintain offices at the field and of the concessionaires who operate the restaurant and other services for the public.

The airport was planned and built with an eye to probable future needs. For although more than 300 landings and takeoffs are being made daily at the field we have by no means approached the saturation point, and even with the expansion in air traffic an-

The Author

Left: View shows the close proximity of the airport to the downtown business and governmental section of Washington. The highway traversed from the bridge in the background to the airport is a portion of the beautiful Mt. Vernon Memorial Parkway. Traffic from the city speeds into the airport through an underpass so that movement of vehicles on the main highway is unhindered by local traffic. The old privately owned Washington-Hoover Airport can be seen just beyond the new field.

ticipated for many years to come, the Washington National Airport may reasonably be expected to handle any increases that may come in the foreseeable future.

Here are a few figures on the cost of the field, operating expenses and revenues. Slightly more than $15,000,000 were expended by the several agencies of the federal government which participated in the construction of the field. This total also includes certain equipment necessary for operation and not actually a part of the construction cost. The present annual operating budget, which is adequate under existing circumstances, is $290,000. All concessions on the airport have been let on a percentage basis, and the minimum return to the government for the first year will be about $400,000. However, this does not include all items of income and it is very probable that total income will run about twice the cost of operation.

Five hangars now under construction will shortly bring the total to six: American Airlines will occupy one and one-half; Eastern Air Lines two; Pennsylvania-Central Airlines two, and the CAA one-half.

Washington National Airport is the first federally built civil airport and the first to be operated by a federal agency—in this case, the Civil Aeronautics Administration. Among the government agencies participating in the planning and construction of the field were: Corps of Engineers, U. S. Army; Public Buildings Administration; Works Progress Administration; Public Roads Administration; and the Public Works Administration. Out of the total of 729 acres comprising the field, 425 acres are "made" land, dredged up from the bottom of the Potomac River.

There are four paved runways. The north-south runway, following the direction of the prevailing wind, is 6,885 ft. in length and 200 ft. wide. The length of the other runways is as follows: northwest-southeast, 5,210 ft.: northeast-southwest, 4,892 ft.; east-west, 4,100 ft. The two shorter runways are 150 ft. in width. Approaches to the runways from all eight directions are entirely free of obstructions so that an approach angle of 40 to 1 is possible.

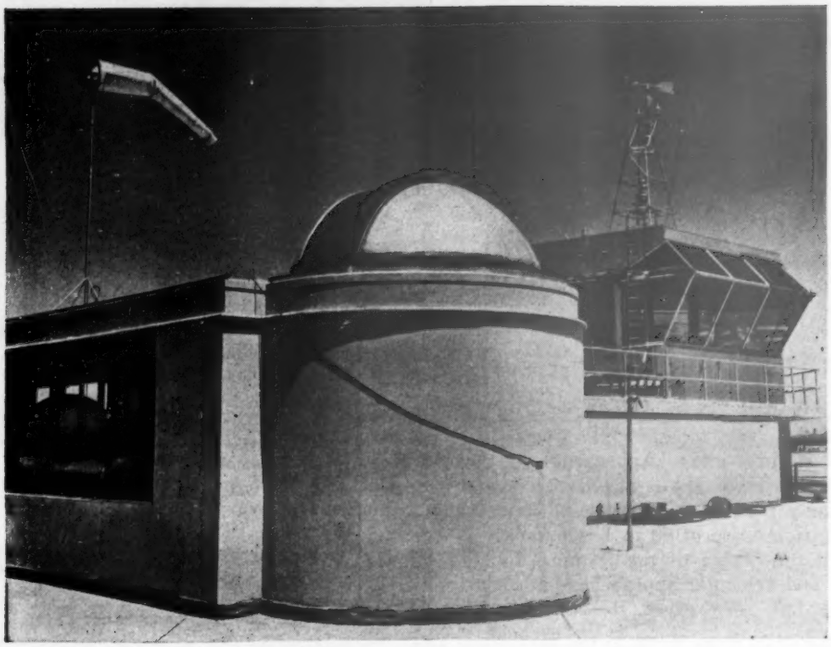
In the design of the terminal building and vehicular approaches particular care has been given the problem of "channelizing" traffic, so as to cause a minimum amount of confusion and maximum speed in handling passengers and cargo. All truck traffic and commercial vehicles serving the airline offices and concessions, for example, are routed through a separate roadway and tunnel underneath the Administration Building. In this tunnel are loading platforms connecting directly with the post office and baggage room. The field is only three and one-half miles from the

Sheltered approaches are provided on either side of the main entrance for the convenience of arriving and departing visitors. Just beyond is part of the area provided for parking of more than 1,000 cars. This is being increased eventually to accommodate 5,000 cars. Some of the parking areas will be terraced so that a full view of the field can be had by visitors while seated in their automobiles.

The airline ticket offices are arranged around the main waiting room. The thirty-foot glass wall overlooks the loading ramp, the major portion of the field, and the Potomac River beyond. North and South Concourses provide additional space where passengers may await their planes for connections in quiet comfort. The stairway leads to the main dining room, while the doors just to the left on the main level open into the coffee shop and grill. The balcony on the left keeps sight-seers and tourists separated from the flow of passengers and airline employees on the main floor.

The nerve center of the entire airport is this modernly equipped control tower. With vision unobstructed in every direction, the control tower operator regulates the arrival and departure of aircraft with clocklike precision. The glass walls of the tower have a soft green tint and are placed at angles designed to reduce to a minimum glare or confusing reflections. Special long-bladed wipers keep the glass free of rain and snow during adverse weather conditions.

Non-flying spectators have flocked to the new airport in numbers hardly anticipated. From the long curving balcony they watch with interest the varied activities and never-ending movement of a busy air terminal.



American Airlines Inc.

Above: On the roof of the airport building we see the government weather station and the control tower for the field. Flight of weather balloons is observed from the building in the foreground.

hotels, office buildings, and post office in downtown Washington. It can be reached by taxi or bus in ten to fifteen minutes, depending upon traffic conditions.

Complete modern equipment of latest design is installed for the efficient operation of the airway traffic control and airport traffic control offices. From the weather station on the roof meteorologists make theodolyte observations to ascertain direction and the velocity of upper air wind currents; inflate and release ballons carrying radio sondes for upper air observation and receive the radio sonde signals.

The proof of the pudding is in the eating. The application of the old parable in this instance is a sound one. For, since June 16 when full operation of the field began, the Washington National Airport has been fulfilling the purposes for which it was designed as well as, perhaps better than, any other large air terminal heretofore placed in operation.

Right: A close-up of one of the turntables with which each loading station is equipped. To the left can be seen the open door of the servicing pit. These underground pits eliminate the necessity for service trucks on the apron. This Aqua Flotation System was designed especially for the needs of the Washington Airport. The freely-revolving turntable eliminates strain and wear on landing gear and tires in pivoting and assists the pilot in bringing his ship accurately to its designated loading position.

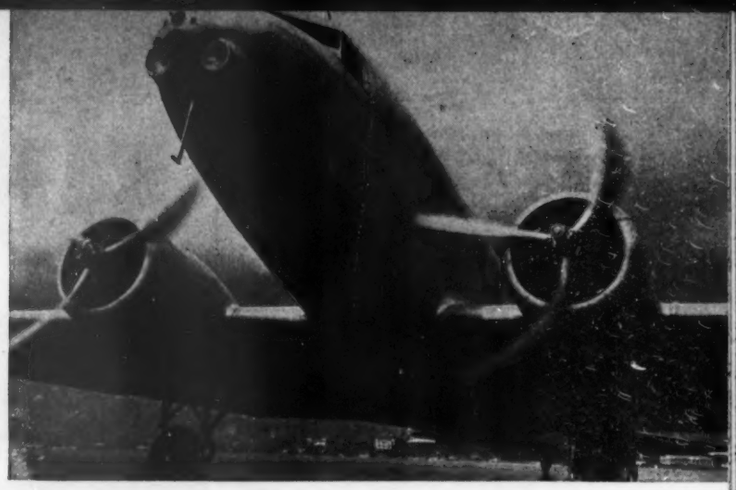
American Airlines Inc.

Right: Passenger's bags are weighed on scales whose dials are located on the counter (under passenger's hand in picture). Bags are then put on trap door in foreground and transferred by chute to the baggage truck to be carried directly to the airliner.

American Airlines Inc.

Left: Next to each plane position is a trap door set in the concrete. Beneath this door is a telephone and a pneumatic communication tube which connects with the ticket office. Agent is shown handing passenger manifest up to stewardess, while talking with the ticket counter.

A Bird Flies on One Wing and a Half



A C.N.A.C. DC-2 at Hong Kong airport.

This is one for Ripley and the aeronautical engineers

By Captain Edward Smith
China National Aviation Corp.

NOT content with operating the "World's strangest airline" (and incidentally one of the busiest), where schedules are canceled in good weather and never in bad, China National Aviation Corp. of Hong Kong has recently performed a feat in aviation history which should be of interest to the "experts."

One of the giant DC-3 airliners, on a scheduled passenger trip to Chungking from Hong Kong, was forced to make a precautionary landing at Suifu because of an air-raid in progress at Chungking. This is not unusual, as many of the cities served by CNAC are subjected to periodic bombings by the Japs and the usual procedure is to land at an alternate field and await the "all clear."

On this particular day, however, five Jap bombers on their way home after the raid, spied the plane on the ground at Suifu. The passengers and crew, in a nearby air-raid shelter, had a ring side seat to a more or less thorough bombing of the airport, during which more than 200 bombs were dropped.

When the smoke cleared away, CNAC'S Captain H. L. Woods (who was shot down by the Japs near Hong Kong in 1938) took stock of the damage and found that one bomb, passing neatly through the right wing, had exploded in the ground, removing the wing just outside the point where it joins the center-section. More than 50 places in the fuselage had been perforated with flying shrapnel. The plane jumped six feet sideways from the concussion, but the gas tanks did not explode and there was no other damage.

Capt. Smith

Suifu is about 900 miles in the interior of China and there are no surface means of transporting a new wing from Hong Kong, except over the Burma Road which would take several months at least. There were many headaches in Hong Kong as we did not have a spare DC-3 wing and the loss of one plane, even for a few months, was a bad blow to operations. Then too there was the risk of losing the plane entirely if it was left unprotected on the field.

There is an old saying—"You don't have to be crazy to fly—but it helps." It seems that out here, this applies to pilots and ground staff as well.

Operations Manager C. L. Sharp,

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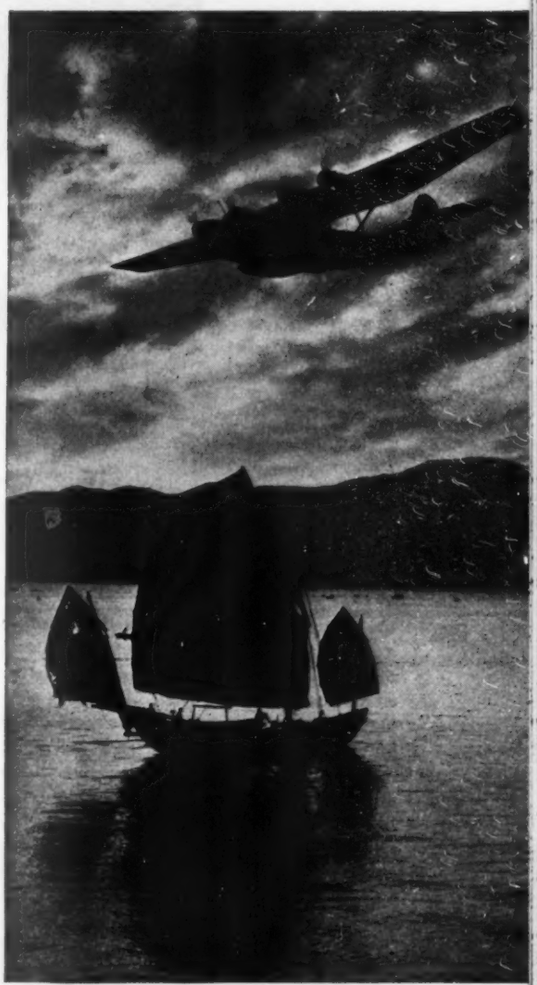


P.A.A. wings over China.

C.N.A.C. Douglas planes on the apron at Shanghai.

Photos except the author courtesy of Pan American Airways.

A row of propellers at the Pawcatuck plant ready for shipment.

Expansion Without Bricks and

When Hamilton Standard was faced with expansion, the management sought out a suitable existing plant and saved time and money

The plaintive whine of the Berliner Profiler was strange to the people of Pawcatuck. But with it came new activity in the vine-clad factory once occupied by Loraine Textiles and long deserted after depression and hurricane. And propeller manufacturing brought new prosperity to Pawcatuck. For other defense manufacturers there is a lesson in Hamilton Standard's selection of a deserted factory in an unspoiled community providing the most economical form of expansion.

PAWCATUCK, Connecticut, has jumped on the defense bandwagon. The butcher, the baker, and the candlestick maker's current counterpart—the electrician's apprentice—are all making airplane propellers for the Hamilton Standard Propellers division of United Aircraft Corporation.

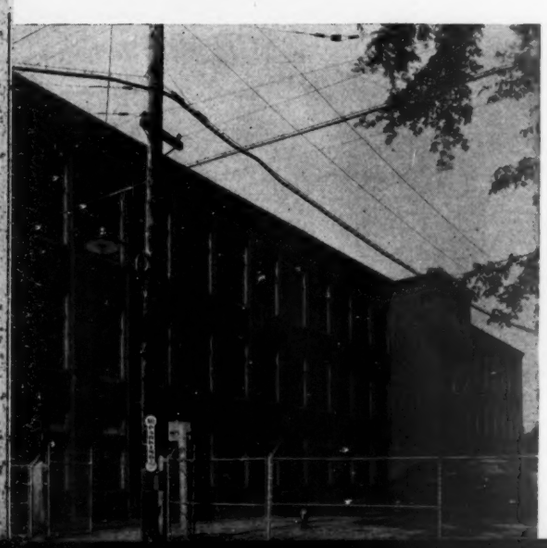
The town's net gain will be a monthly payroll of approximately $200,000. The nation's will be 1,000 propellers a month by fall, and more by the first of the year.

It all began less than nine months ago. Hamilton Standard was faced with the urgent necessity of doubling and redoubling its production schedules to meet the critical and growing demands of a rearming nation. The company, which produces three times as many propellers for advanced training and combat planes as any other American manufacturer, had already instituted a rearrangement program in its East Hartford plant. An addition, bringing the productive floor area from 250,000 sq. ft. to approximately 300,000 sq. ft., had been built on the south side of the old plant. But more than anything else the installation of new specialized high-speed machinery and a conveyor system had squeezed every inch of space to its greatest productivity and actually doubled its efficiency.

In choosing Pawcatuck, Hamilton Standard officials gambled against long odds. The plant offered promise to only the most optimistic. Lint clung to every rafter and beam. The roof leaked, windows were broken, flooring was rotting away, and what paint remained was chipped and faded.

The town offered very little in the way of skilled labor. Indeed it's a safe guess that few potential employes had ever seen an airplane propeller at close range. Few had ever worked with machine tools.

But with the war spreading, domestic demands and allied pleas growing, there was no time for hesitation. In two months the building was transformed. Paint was applied; flooring replaced; roof patched; windows repaired; electrical wiring renewed and extended; exhaust systems and com-



Left. The Pawcatuck plant of Hamilton Standard after renovations were completed.

pressors installed; parking areas graded; offices built; and machinery installed. On January 1 operations began.

After the renovation was started, one of the problems confronting Hamilton Standard officials was the task of hiring and training its manpower and selecting personnel from the East Hartford plant to go to Pawcatuck. Experienced men had to be selected as supervisors and foremen and rapidly put through the necessary training to prepare them for the job of handling personnel later on. Several foremanship discussion groups were inaugurated to exchange the ideas and experiences of the individuals to the benefit of the entire group. These have been continued at the request of the men themselves.

The Pawcatuck plant was set up with approximately 150,000 sq. ft. of productive area in use as a combined manufacturing and propeller assembling plant—manufacturing operations to include all operations necessary to process blades from rough forgings to finished products for assembly in the propellers. Rather than overtax the facilities of the machines and men of the other plant, Hamilton Standard Propellers had already studied the possibility of further subcontracting with several manufacturers to machine the integral parts of the propeller hub.

Mortar

Subcontractors began making spiders, barrels, gear segments, rotating cams, and stationary cams for the dome assembly. Small parts continue to come from the various venders who had been supplying the East Hartford plant, and where the part had been machined in East Hartford, provisions were made to expand machine lines for production to the Pawcatuck plant.

The first employes—70 were hired in January—were started on the basic grinding operations. The number of employes increased over the four months period from January to April, until 136 men were grinding, with three shifts in operation, and additional men being trained as operators for the machines.

In May, the first units were shipped and during June and July the plant met increasingly difficult schedules. Each month will see the quota increased toward peak production in November or December.

A potential stumbling block to successful set-up of the plant, was scheduling—which comprises ordering and delivery of machinery, special tooling, jigs and fixtures, and shop equipment; plant rehabilitation and adaption of the old facilities to modern requirement of a propeller factory. It further implies bringing purchased parts and sub-contracted parts to the plant according to plan so that when the men were ready to start on a production basis, each project would prove a perfect stepping stone to the goal of "production on schedule".

Machinery for the Blade Department at Pawcatuck was selected and approved through the tool engineering department in East Hartford, thus eliminating the necessity of establishing a temporary organization for machine procurement. Orders were placed in the summer of 1940 for earliest possible delivery. Schedule called for the first machines to reach the plant in the latter part of December, continuing into March of 1941. The hiring schedule was carefully synchronized with delivery of machinery to guard against having more employes on the payroll at any one time during the training period than could be accommodated with available equipment. Tool and equipment requirements were compiled for

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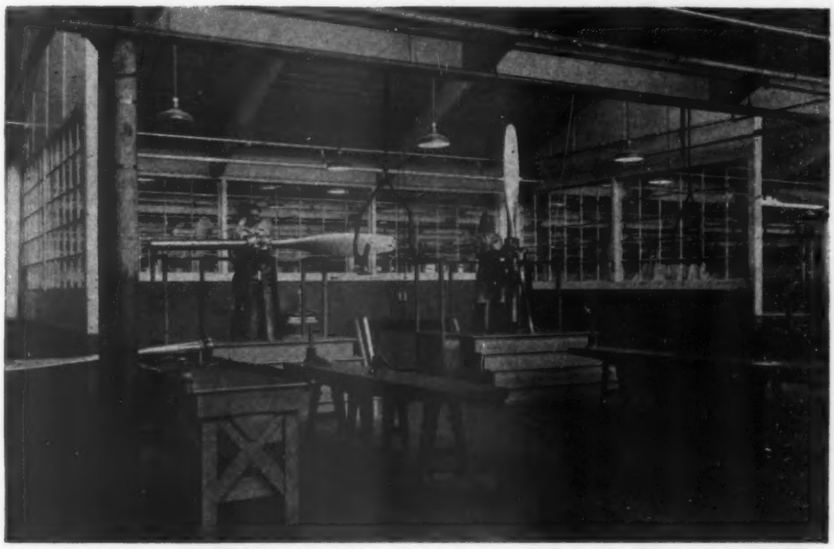
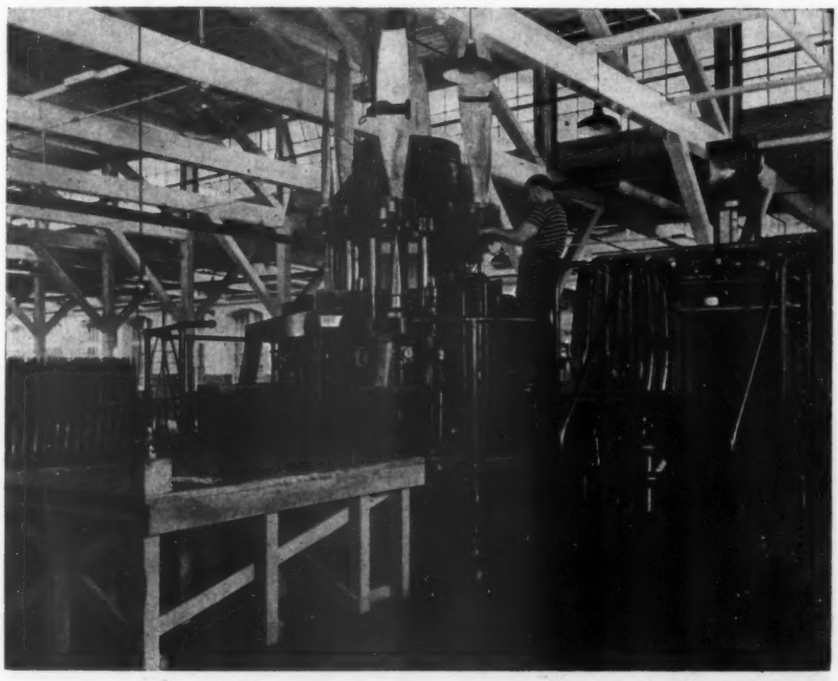




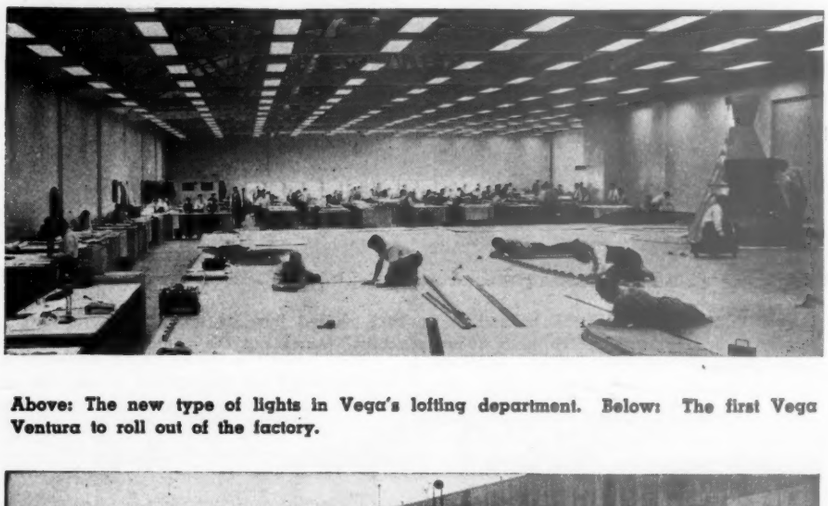
Above: local labor has been trained to do such skilled jobs as balancing propellers. Below: A Barnes drill, which is a 26-ton machine, reams out the conical hole in the blade shank.

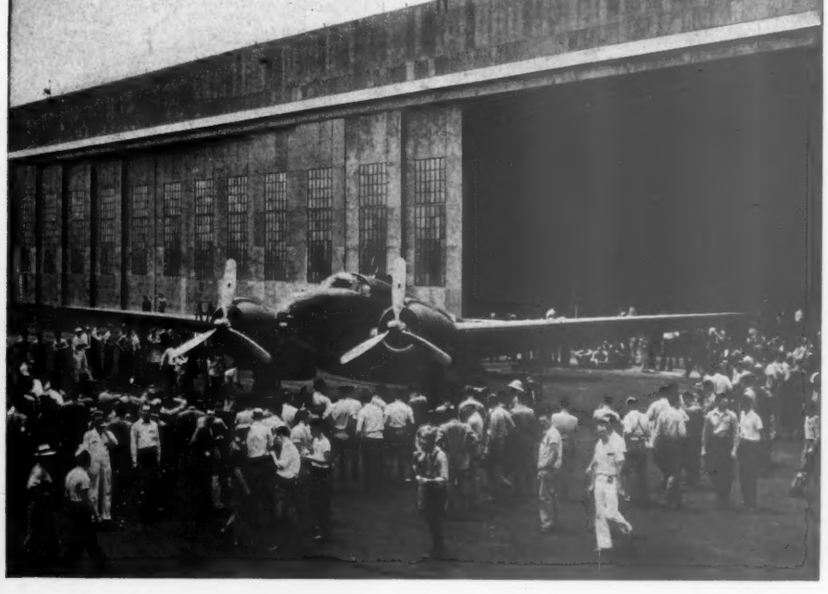
New Light on Production Problems

Vega factory has world's largest installation of fluorescent lights.

By Charles F. McReynolds
Pacific Coast Editor, Aviation

WITH aircraft factories working around the clock it has become absolutely vital to perfect artificial lighting to the point where production will proceed at maximum efficiency day or night. It is fortunate for the success of our current defense effort that the fluorescent light was developed in time to meet this need. Engineers of the Lockheed-Vega organization turned to fluorescent lighting in their search for an ideal system of artificial illumination. It was necessary to conduct research beyond anything previously done in this field. The result is a new type lighting fixture designed to meet the specific need of the new Vega plant at Burbank, Calif. Studies of lighting problems led to the world's largest single installation of fluorescent lights in a plant which is 100 percent fluorescent lighted. There were many difficult technical problems in the path of this lighting achievement, some of which were declared insurmountable by lighting experts. For example, the installations above the final assembly section are the highest fluorescent mountings in existence, being 40 ft. above the floor at some points and 35 ft. at others. Major problems were presented by this installation from a service standpoint alone, as it is difficult to service lighting fixtures at such a height. But this problem has been solved through provision of special portable service cranes permitting cleaning and replacement of tubes without interfering with production on the floor below.





Above: The new type of lights in Vega's lofting department. Below: The first Vega Ventura to roll out of the factory.

There is a total floor area of 1,334,000 sq. ft. in the Vega plant and a total of 36,524 fluorescent light tubes are used to illuminate this area. The result is almost literally to "pave" the ceiling of the plant with light. Since the light sources are almost infinitely numerous, and each individual unit is of low intensity, high area type, the result is to produce an almost magical condition of high light intensity at the working level without any awareness of the source of light. The worker is always bathed in light from all directions and so does not waste a single moment of production time while maneuvering to get the light behind him, or in front of him, for purposes of vision. Some conception of the vast size of this lighting installation is gained by stating that these 36,524 light tubes, if placed end to end, would measure approximately 28 mi. long, about half again as far as the largest comparable fluorescent light installation previously made. These tubes are contained in 10,392 different lamp fixtures of special type developed by Vega engineers.

In the main manufacturing building there is one vast unpartitioned ceiling with an expanse of 11-½ acres, measuring 600 by 850 ft., which carries 17,894 light tubes in 4470 lamp fixtures. These lights cover a working space of 510,000 sq. ft., or enough to hold ten football fields—including end zones. Including both main floor and mezzanine, the

(*Turn to page 168*)

Vega's New Plant

New plant expects to achieve high output per square foot of factory space.

By H. E. Ryker *Vice President in Charge of Manufacturing, Vega Airplane Company*

BY virtue of its well-planned layout, and the method of continuous line production both as to parts assemblies and the airplane itself, the new $7,000,000 factory of the Vega Airplane Company was built especially to speed production. Most airplane plants have been extended after initial erection, which, while necessary under the National Defense emergency, cannot be accomplished without some confusion.

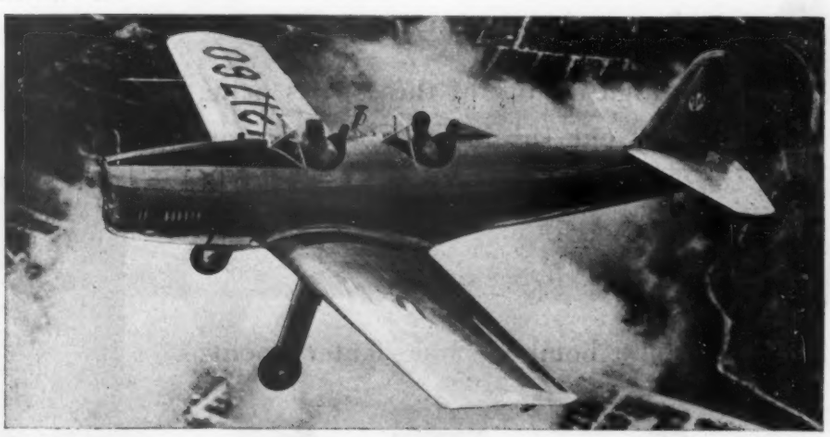
Vega, located adjacent to Lockheed Air Terminal in Burbank, California, will lend itself to much greater productivity than the average plant. To be perfectly frank about it, we expect to achieve a higher output of pounds of air frame per square foot than the average for the industry. That is an ambitious program. But Vega is an ambitious company. Furthermore, we have 1,334,000 sq. ft. of what we believe to be the most modern aircraft manufacturing facilities the industry has known.

Many experts believe, and say quite openly, that better production cannot be reached because of the inexperienced workers which are the only ones available. Such manpower is supposed to slow things down considerabily. Such was not the case at Lockheed, our affiliate, last year, and there is no reason it should be so at Vega. In addition to the handicap of untried men, buildings were being torn down and new ones built up. Despite the attendant confusion occasioned by all this construction as Lockheed expanded more than a million square feet, new records for production were achieved.

No rebuilding program will present its accompanying problems at Vega. And we believe that we can solve the inexperienced employee problem at Vega exactly as we solved it at Lockheed. The secret is to train a man for one job and keep him on that job until you have someone else fully trained to take his place. Then promote him to a position of greater responsibility. But don't keep shunting him back and forth, all over the assembly line. Let him do what he knows how to do thoroughly, and leave other jobs to men who know those jobs thoroughly. This system cuts down production time by 60 or 70 percent.

The general plan and layout of Vega is to obtain insofar as possible a continuous flow of production, thus minimizing the storing and handling of parts and assemblies. For instance, small assemblies will be passed directly on to the next assembly station, instead of being stored in and reissued from a parts storeroom. In turn, the larger

(*Turn to page 164*)



Vega-35, a primary-secondary trainer, on a flight over Burbank.

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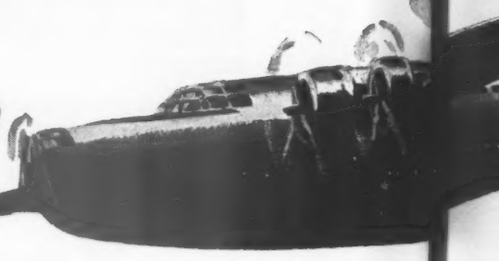

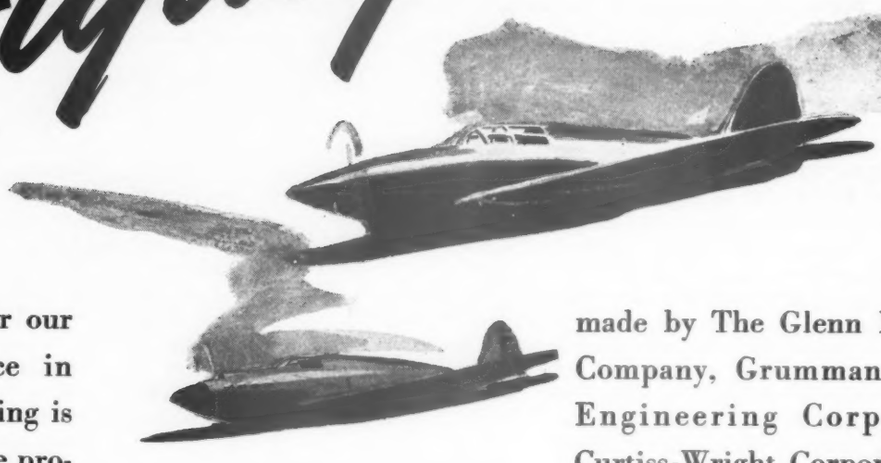

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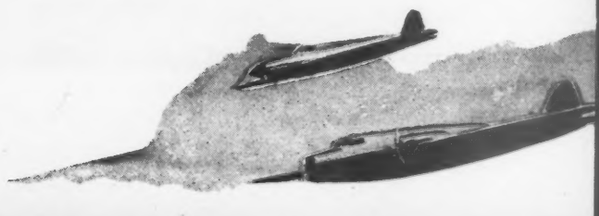

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Machine parts, printing plates, newsreels, styles are common cargo for air shipment—and commodities ranging from gardenias to furnaces are being transported by plane.

Air express service extends across the continent and the Pacific Ocean; and from Alaska to the Argentine. TIME Magazine ships 20,000 copies weekly to Latin America—they are on the news stands of Buenos Aires Monday, three days after the magazine goes on sale here.

In fifteen years, delivery speed by air has doubled; rates have been cut two-thirds; mileage flown has multiplied ten times over. As yet, however, the movement of freight by airplane is still an infant industry. Lower rates will come through new low-cost cargo planes and other developments; the quickening pace of United States production will continue to put more cargo in the air.

The development of this industry will call for more and more planes—and technically trained men to keep them flying.

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FLYING Test Stand

New instruments and methods in flight testing aircraft engines constitute a laboratory aloft

By Herb Shebat
Wright Aeronautical Corp.

A YOUNG engineer just transferred to our flight test section made a suggestion which amazed me. "I would like," he said, "to change the engine installation in a test plane, so it will duplicate that on the test stand."

"You see," he continued, before I caught my breath, "the data taken in flight cannot be correlated to that taken on the stand, and I'm sure that if we can change the plane we can correlate it."

I tried hard to tell him, but I'm not sure I was convincing, that the way to correlate the data was to change the test stand, so it would duplicate an airplane installation. I explained that our one ultimate object is to build engines which perform well in flight, that test stand research is an intermediate step and very valuable when the data it produces are applicable to flight conditions, and that, if the test stand data are not applicable to flight conditions, the test stand, rather than the airplane, should be changed.

This may seem strange to you, but I'm a pilot, and like other pilots, I can't agree that all engines, including those which fly, are just alike. True, they are all conceived in a drafting room, born in a machine shop, and nursed on a test stand. But after it's weaned, the airplane engine must operate in an environment, which is different in at least three important ways from test-stand conditions.

First: in flight the movement of the cooling air is almost entirely dependent upon the velocity of the plane which may vary all the way from zero to 400 m.p.h. or more. If an airplane engine overheats, you cannot correct the trouble by putting on a new fan belt.

Second: engines are subjected to movement and acceleration—on three axes, and they must operate in every conceivable position, including inverted.

Third: the wide changes of atmospheric pressure and density affect the engine's power, its ability to cool itself, and its ability to pump fuel and oil.

All of these things affect the engine directly, and also indirectly, through its accessories.

Test stands have been built which simulate many items of the flight condition, such as the velocity of cooling air, the density of the carburetor air, and the position of the engine. But it is perhaps impossible, and is certainly impractical, to simulate all of them.

Let us go into each of these items a bit farther. First, the problem of cooling: it seems to me that our present engines, with their high horsepower and comparatively low cruising power, are the direct result of the type of airports which are available. Do you remember the high wheeled automobiles of the days before we had paved highways? Well, I think the same thing is happening in aviation today. Now we must build engines which can deliver a certain cruising power continuously and another, much higher, power which can be used to get the plane off the ground. To do this, it must accelerate a heavy plane (say 10 lb. per take-off horsepower) from zero to 70 m.p.h. in about ¼ mile, and it must continue this acceleration up to about 100 m.p.h. within the next ¼ mile or so. During the first part of this process, the landing gear is on the ground, and during the second part, the gear (which is a very heavy drag, as it lacks streamlining) is being folded.

When the landing gear is folded, the take-off is finished, and the cooling conditions change greatly. The power is reduced 25 percent or more and the speed is much higher, so a much greater flow of cooling air is available. During take-off, it is necessary to cool the engine, in part, by surplus fuel; but we can't keep that up, or our fuel consumption would be prohibitive, so we use take-off power for as short a period as possible and get into the cruising conditions, starting with a cruising power climb.

So far, the flight conditions can be approximately duplicated on a test stand. As the plane starts to climb, the air density drops and its effectiveness, as a coolant, drops too. This is a variable, which is not built into the stand.

Motion picture photographs of a duplicate instrument panel installed in baggage compartment. Camera (black square, center of panel) kept complete record of all instruments as reflected in mirror.

To make the whole thing more complicated, the temperature of the atmosphere, our coolant, also drops with increased altitude, thus improving the cooling. This is another variable which is not duplicated on the stand. These two variables move in opposite directions, as the plane climbs. Flight test data have accumulated and have pretty well established the relationship of these two variables. The drop in density is a percentage of its original density. This results in a corresponding percentage drop in the temperature differential between the cooling air and the engine metal (cylinder fins). The temperature drop affects this differential by being added directly to it. In standard atmosphere at 21,800 ft. the density is one-

(Turn to page 176)

Airplane Hydraulic Systems

By Edward M. Greer
Simmonds Aerocessories, Inc.

AS the science of aerodynamics developed, it was learned that higher efficiency of aircraft could be obtained by the reduction of its parasite drag. Experiments made by the N.A.C.A. and many schools interested in the subject have discovered that the resistance of the landing gear sometimes runs up to 40% of the total drag. Structural members, such as wing struts, braces, guy wires and tubes which contributed to the total drag, were eliminated with increased knowledge in structures design.

Streamlining tires and undercarriage members helped a little. However, with the advent of larger and faster airplanes it was found imperative to remove the landing gear from the slipstream of the airplane. At first, this was done by pulling the undercarriage up by means of a hand crank, cables and pulleys. This system soon proved to be too bulky and inefficient, aside from requiring the pilot's attention when he needed it most in making a landing or a takeoff. An electric motor then replaced the hand crank, but problems of linkage persisted and the added weight of the electric motor was objectionable. The hydraulic actuating system was then introduced and found quite satisfactory. The great advantage of this system is that a central power unit, the pump, can be used to operate all the components through a series of tubes, which can be directed anywhere in the airplane as easily as electric wires without regard for transmission of power in different directions or the problems of torsional stresses or linkage connections.

Although the hydraulic system was primarily used to operate the landing gear, the art has developed to include the tail wheel, wing flaps, gun turrets, bomb doors, engine cowling flaps, gun firing gear, control surfaces, engine controls and the automatic pilot, all with a single power unit and a system of valves and actuating cylinders. Control valves for all the units can be mounted in a single manifold on a convenient panel in the cockpit with the distribution units on another manifold mounted conveniently and the actuating cylinders distributed to directly operate the required mechanisms. Although the loads required to operate the different mechanisms may vary, the desired effect may be obtained merely by varying the area of the actuating piston.

The hydraulic system is comprised in all cases of three main units. They are, first, the pump which supplies the power to operate the system; second, the control valves which control the direction of flow of power and hence the choice and direction of the actuating units and, third, the actuating components which comprise a piston and cylinder arrangement. The simplest type of hydraulic installation is shown in Figure 1.

This installation consists of a hand pump "A", a selector valve "B" and a pair of actuating cylinders "C". By shifting the handle to the down position and then operating the hand pump, power is forced into the cylinders causing them to extend the landing gear. By setting the valve in the neutral position, the oil is trapped in the cylinders causing the landing gear to be hydraulically locked in position. By setting the valve handle in the "UP" position and then operating the hand pump, oil will be forced under pressure to the opposite side of the cylinders causing them to retract the landing gear.

The system can be multiplied to actuate the tail wheel and flaps in addition to landing gear, simply by adding a tail wheel actuating cylinder to the landing gear circuit in Figure 1, and by connecting a flap selector valve and flap operating strut in parallel to the above circuit. A complete and comprehensive system, is shown in Figure II. In this airplane, the pump is located in the pilot's compartment at the left side of the co-pilot's seat. This pump is fed from a reservoir mounted on the firewall above the level of the pump. The four way valve which operates the landing gear retracting cylinders is located on a panel to the left of the co-pilot's seat. To retract the landing gear, the handle of the control valve is pulled to the position. The pump is then operated until the wheels are fully retracted. A hard pull on the handle of the pump is necessary to insure that the wheels are full up into the nacelle structure. By returning the control handle to neutral, pressure is locked in the cylinders thus keeping the wheels in the up position. If the valve handle is pushed down and then the hand pump operated, pressure will, by means of the operating cylinder, extend the landing gear until it is full down. A spring loaded safety latch installed in the rear wall of the nacelle moves into a notch on the operating cylinder rod, thus locking the landing gear in the down position. When the control valve handle is placed in the up position, pressure is forced into the bottom of the latch cylinder, forcing the latch upward, thereby releasing the operating cylinder rod and thus the landing gear.

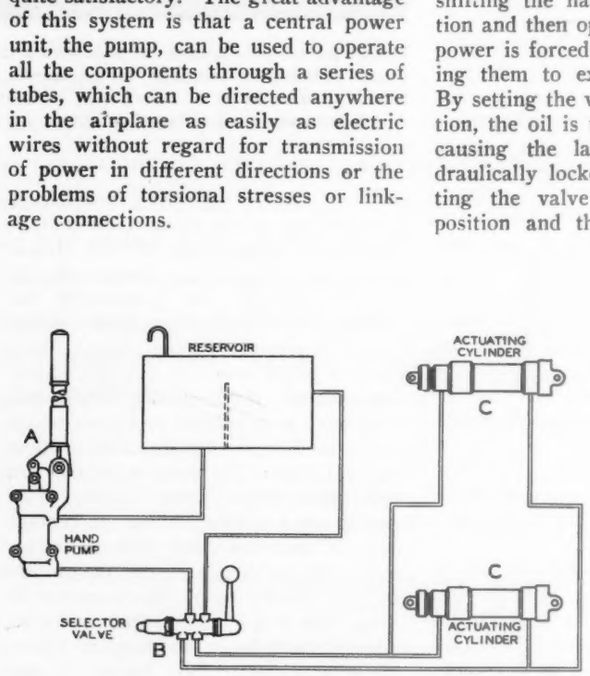

FIGURE I

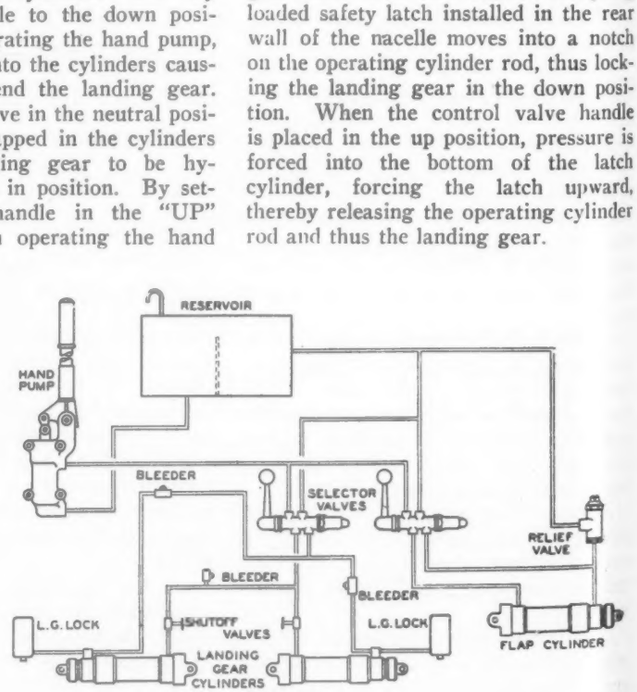

FIGURE II

A signal system is connected with this system whereby a red warning light goes on when the control handle is pulled into the "up" position and will stay on until the handle is returned to neutral. When the handle is pulled to the down position, a horn sounds until the landing gear is in the full extended position. As the latches lock the landing gear in the fully extended position, a green light goes on, the horn becomes silent and the red light will go off. The wing flap four way control valve is located on the floor at the right side of the pilot's seat. The hydraulic actuating strut may be located in the center wing panel. A relief valve is inserted in the system to prevent lowering of the flaps at excessive speeds. If the flaps are retracted and excessive wind loads are applied to the flaps, pressures above the relief valve back to the tank, thus causing the flap to move upward. In some cases, a pressure gauge installed near the relief valve line is desirable to indicate high loads on the flaps. If the handle of the control valve is placed in the extreme forward position and the hand pump operated, the flaps will be lowered. Returning the handle to neutral will lock the fluid in the cylinder and thus hold the flaps in position. If the control valve handle is placed in the extreme rear position, the pressure on the rod end of the actuating cylinder will bring the flaps up when the hand pump is operated. The neutral position of the control valve again locks the flap in position. When in flight, extreme air loads on the flaps will raise them by by-passing the fluid through the relief valve as explained.

An indicator located on the instrument panel which is connected to the flap actuating strut, will give the position of the flaps at all times.

A pressure gauge connected to the line which feeds the upper ends of the landing gear retracting cylinders is located in the cockpit indicating the pressure in the retracted position. Shut-off valves, of the ordinary hand operated globe type are provided next to the upper end of the retracting cylinders so that the landing gear can be retracted and the fluid trapped in the cylinders. This permits pressure in the rest of the system to be relieved and the pump lines or latches to be disconnected and repaired. Bleeder valves or traps are provided in the highest points of the system to remove all the air from the system.

Present day practices have progressed such that the above system would not be acceptable. Locking a cylinder by trapping oil in its cylinder has proven inefficient as leakage and temperature change would effect the position of lock. Line disconnect valves have long since replaced hand operated globe valves mentioned in connection with the landing gear lines above.

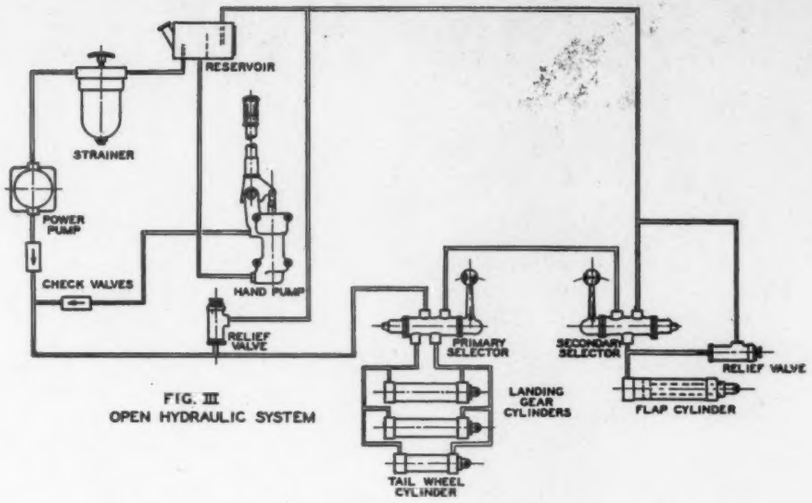

FIG. III
OPEN HYDRAULIC SYSTEM

As hydraulic systems became more extensive the capacity of a hand pump as a power unit was found inadequate. A power driven pump was then added to provide an adequate source of pressure, and the hand pump was retained for emergency operation in case it is mounted on the accessory case of the engine, or it may be driven by an electric motor mounted in any convenient location, usually near the reservoir. In present systems, the most popular type pump is of the gear type, with capacity ranging from 1½ gallons to 4 gallons per minute and operating between 700 and 900 lb. per square inch.

Since the pump is continuously operated by the engine, fluid is continuously being pumped through it and the pressure is built up. This pressure must be relieved when the actuating equipment is not being used to prevent excessive pressures and thus injury to the system. One manner of accomplishing this is to by-pass the fluid through a relief valve; however, this is very inefficient as energy is being taken from the engines and dissipated as heat. The heating of the fluid is highly objectionable as the leakage through the valves and seals goes up with a rise in temperature and also because temperatures can cause many other failures including cracking of the fluid. Oil coolers have been employed with some measure of success to prevent this, but as a whole, the loss of power through heat dissipation prohibits the use of this system.

The simplest form of hydraulic circuit using an engine driven pump is known as the open circuit and is illustrated in Figure III. The main feature of this system, the selector valves employed, have their pressure ports open to their return ports in the neutral position, and they are connected in series with each other. Thus, the fluid from the pump will flow through the landing gear selector valve, which we may call a primary, and through the flap operating valve which may be called the secondary and back directly to the tank. The build up of fluid pressure when the system is open will be equal only to the back pressure through the valves and lines and will probably not exceed 30#/in.², when the correct capacity pump is used.

In the system illustrated, the valves are mounted on a control panel in the cockpit of the plane. When the pilot moves the handle of the primary valve to the down position, the flow is cut off from the secondary valve and pressure is built up in the landing gear and tail wheel cylinder, forcing them to extend. When they have reached their full extended positions, the fluid is by-passed through the relief valve which emits a shrill whistling signal. The pilot will then return the handle of the control valve to neutral allowing the fluid to again by-pass through the valve. Fluid is thus trapped in the cylinder, hydraulically locking it in position.

To retract the landing gear and tail wheels, the primary control valve handle is placed in the "up" position. The flow to the secondary valve is again cut off, but this time pressure is built up in the landing gear and tail wheel cylinders, causing them to retract. When these components have reached their full "up" position, the fluid is again by-passed through the relief valve as the pressure builds up giving the pilot the signal to bring the selector valve handle to neutral, thus by-passing the flow and hydraulically locking the components in their "up" position. The secondary selector valve which operates the flap is so arranged that it by-passes the fluid in the neutral position. With the handle in the "down" position, pressure is built up in the flap cylinders, extending them. In most

(*Turn to page 152*)

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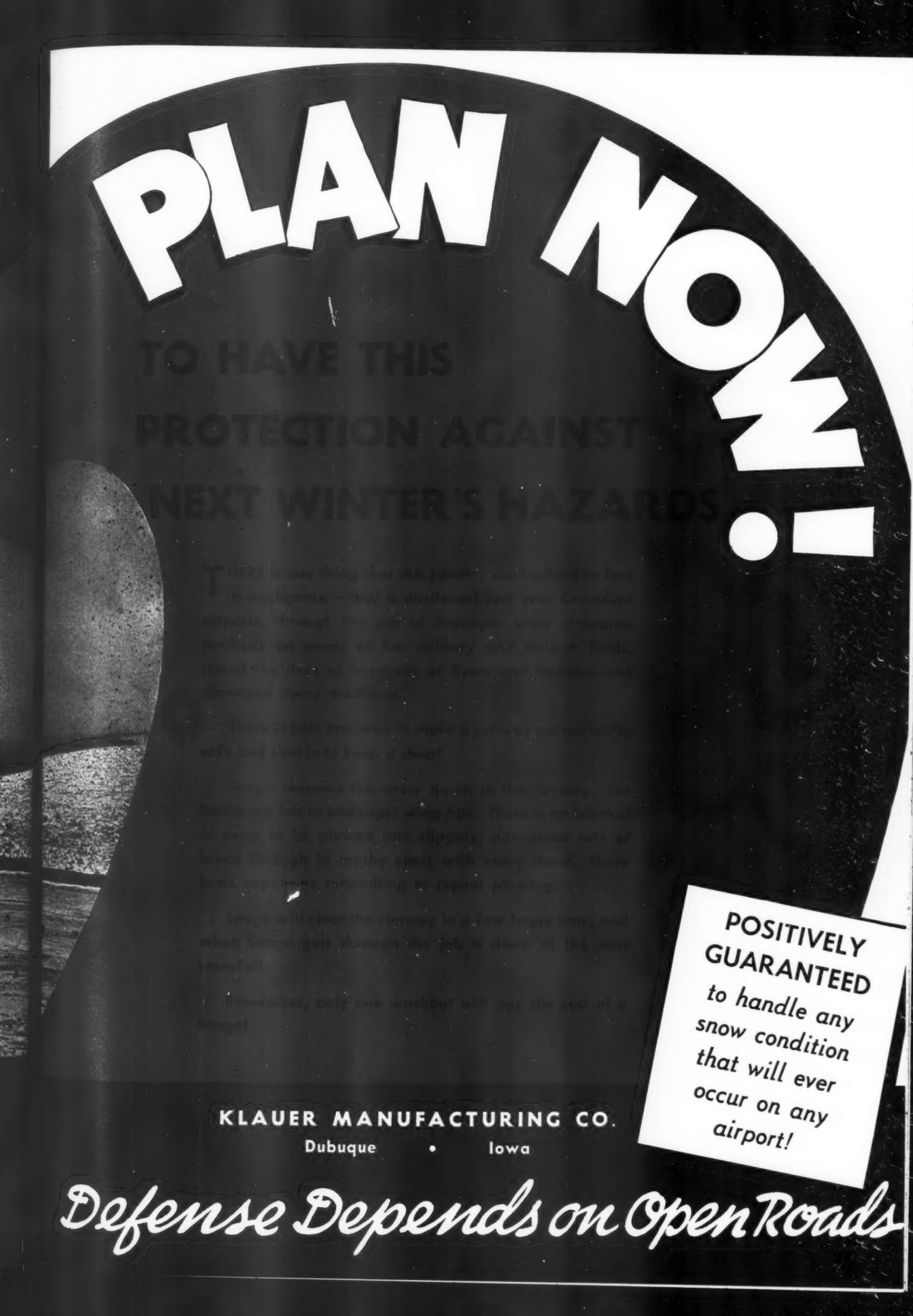
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British Tube and Section

By D. J. G. Rowe, B. Sc.,
Metallurgist, Mining & Chemical Products, Ltd.[1]

ONE of the important operations in aircraft construction is the bending of thin-walled metal tubing accurately to given radii. Where formerly the results, dependent almost entirely on the human element, were varied and uncertain, today they are as precise as the boring of a cylinder or any other task performed to close tolerances.

To prevent the tubing from flattening at the point of bend, some form of filler is necessary. Among the materials used for this purpose with varying degrees of success are sand, lead, resin, tar, spiral springs and internal mandrels. All have their limitations, usually failing when attempting an acute bend with thin walls. Packing a tube with sand tightly enough to support the tube wall, is a tedious and uncertain process. Lead shrinks in solidifying, lessening its supporting value. Resin and tar are effective up to a certain point, but cannot handle the sharper bends. In addition, they are unsatisfactory to work with and the danger of burns to the operator is considerable. Spiral springs and internal mandrels can only be used on the gentler bends.

Another serious objection to all these fillers, except the spring and mandrel, is the difficulty of completely removing all traces of the filler after bending. Small particles left in the tube and subsequently becoming dislodged may cause serious trouble in service, or if left in the tube cause marked weakness in adjacent regions after processes involving heat treatment.

The prevailing practice in aircraft plants in England and the United States is to use bismuth alloys as a filler. Cerrobend,[2] an alloy of bismuth, lead, tin and cadmium, has been specially developed and its peculiar properties make it an ideal filler for tube bending. Its low melting point, 160 deg. F., permits operating temperatures approximating boiling water, thus obviating any ill effects to light alloy tubing. The alloy expands slightly but definitely (approximately 0.006 in. per in.) on solidifying. This tends to hold the tube wall in actual tension at every point, affording a support unequalled by any other filler and enabling bends to be made which have proved impossible by any other means.

After bending, the alloy is easily and completely removed by plunging the formed tube in boiling water and letting the filler drain out. If the tube is oiled internally before loading, there is no possibility of this filler coming into actual contact with the tube wall, as the chance of the oil film being broken at the maximum operating temperature of 212 deg. F. is extremely remote. Thus any tendency of filler and tube material to alloy is entirely removed.

After unloading the filler in boiling water, any minute drops of Cerrobend retained in the oil film may be solidified by plunging the tube in cold water and the solid beads so formed are swept out completely by one application of a pull-through.

Molten Cerrobend normally cools and crystallizes very slowly, resulting in a coarse crystal structure, which is quite brittle. If, however, the alloy is rapidly chilled and solidified suddenly, it takes on a very fine-grained structure. In

[1] (Published through the courtesy of *Sheet Metal Industries*, England).

[2] Cerrobend is a product of Cerro de Pasco Copper Corp., New York.

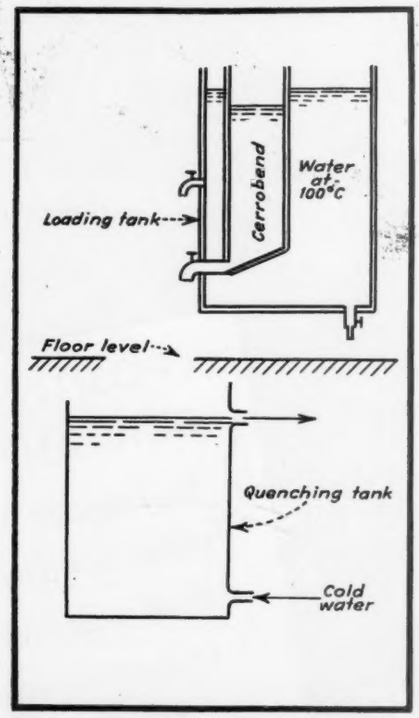

Fig. 1—Arrangement of loading and quenching tanks for the handling of tubing with Cerrobend filler in continuous production work.

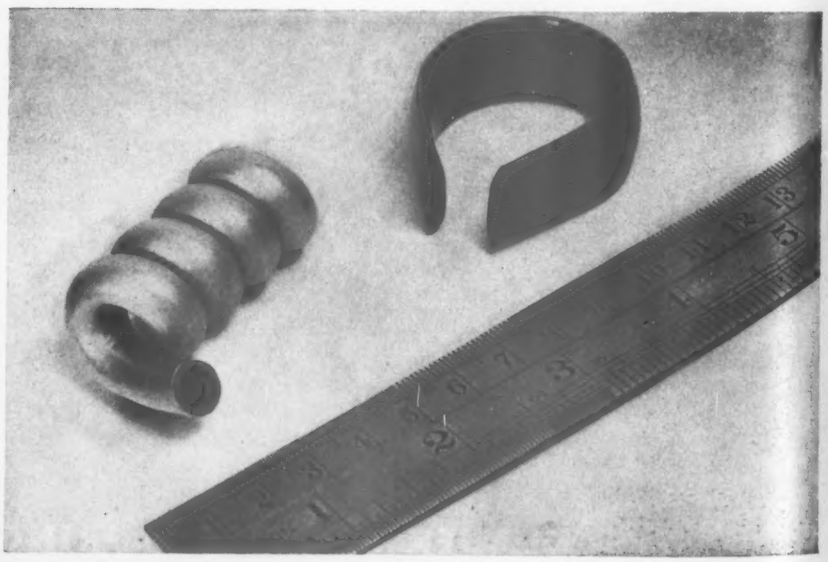

Fig. 2—An aluminum tube 0.25 in. in diameter hand wound round a ⅛ in. bending block with no rippling or buckling. Also bronze tube of 0.0035 in. wall thickness for pressure gauges bent with Cerrobend with complete absence of rippling.

Forming

this condition it has an elongation factor of 140 to 200 percent—a figure far in excess of that of any tube material.

In using Cerrobend for tube bending, the alloy is put in a clean ladle and covered with water. The ladle is then heated until the water is at the boiling point and the Cerrobend completely melted. Prolonged heating should be avoided as this tends to raise the alloy to too high a temperature, because it is a relatively poor heat conductor. The boiling water is poured off the top of the ladle into the tube, which has previously been oiled internally with a fairly thin machine oil and

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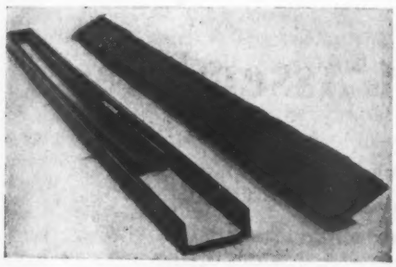


Fig. 4—Section located in mold. Note locating pads and rubber joint to loose side of mold.

Fig. 5—Preheating mold and section with boiling water.

Fig. 6—Plunging loaded mold into quenching tank.

Fig. 3—Modern aircraft construction. All tubular members of this aircraft nose unit have been bent with Cerrobend.

Fig. 7—Block of Cerrobend in which section is embedded mounted in bending machine.

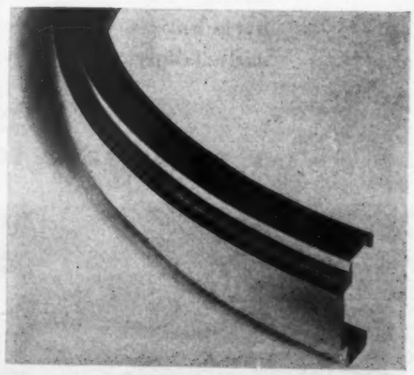
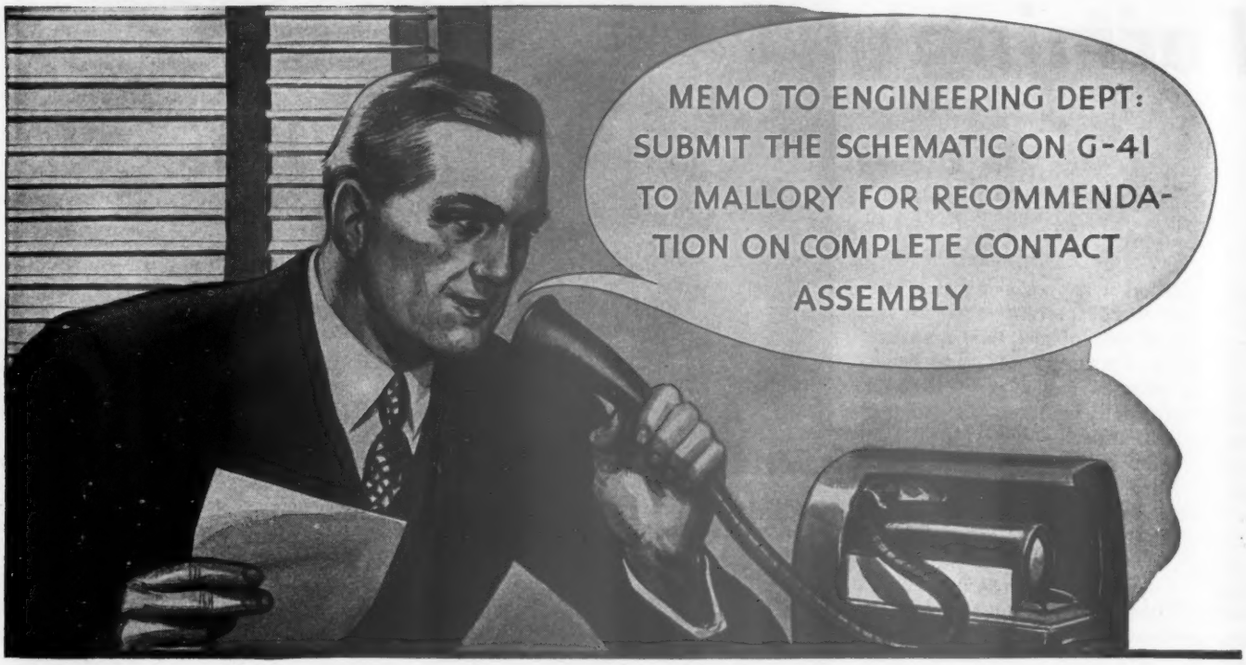


Fig. 8—Typical section after bending. Note how exact cross section was retained. No spreading, no rippling.



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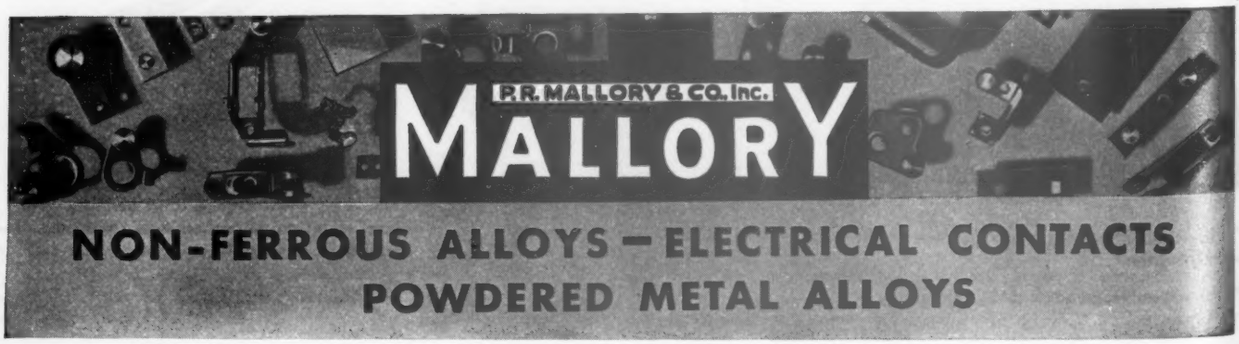


New Reproduction Process At Republic

By Bruno M. Smiling,

and Ben Rudnick *Photochemist,*

Republic Aviation Corporation

One of the printing frames used in the Republic process.

SPEED in production necessitates the extreme development of all ingenious resources. Probably in no other manufacturing industry engaged in fulfilling national defense contracts has this been so evident as in the aviation industry.

A concrete example of such ingenuity exists in the engineering and tooling departments of the Republic Aviation Corporation at Farmingdale, N. Y. and was evidenced in the great interest aroused by the public announcement of the U. S. Army Air Corps, that the new Republic P-47 "Thunderbolt" was being test flown.

The development of this new heavily armed and armored pursuit plane, the first of its class to use a 2000 hp. engine, is the result of the skill of the design and production forces of Republic Aviation.

Already acclaimed by Army fliers and engineers for manufacturing the fast Republic P-43 "Lancer," the engineering staff, paced by Alexander Kartveli, the company's vice president and chief engineer, the designer of both the "Lancer" and the "Thunderbolt," shot the production of the new plane across the drafting boards and through the shops in time unthought of and considered impossible a short time ago.

One of the interesting sidelights on the production of the P-47 "Thunderbolt" is the story of the novel means of reproduction employed by the Republic Aviation tool engineers and developed by the authors under supervision of Hans Lasker, acting general superintendent.

The authors. Left, Ben Rudnick. Right, Bruno Smiling.

Time and skill being at a premium, after an exhaustive study of the existing methods of reproduction, it was determined that the use of a camera and lens was not desirable as a means to be used by men unskilled in the reproductive arts. It was felt that some means must be found, whereby the difficulties encountered could be overcome. We have, with our new patent-pending method, excluded the use of a camera.

Reproductions are made by the contact method. A broad example of this would be the means that is employed in blue printing. The originals and reproductions are not limited to any dimensional sizes. For example, the entire loft floor can be reproduced at one time, as means can be employed to permit the handling of sheets of immense sizes.

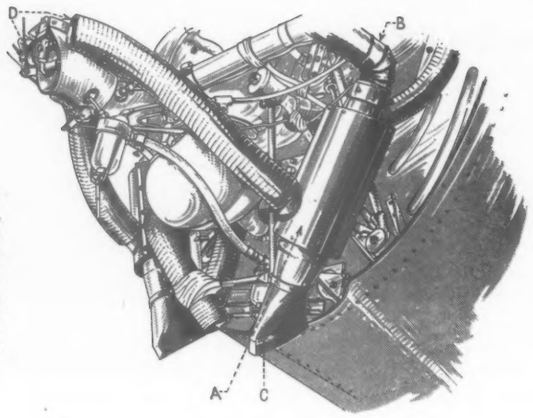
The material on the loft floor or the master layout sheet is given a luminescent coating. A masking coating is applied over this luminescent coat after the coat has become dry and hard. When the masking coat is dry, it is ready to receive the drawing. (The masking coat is of contrasting color to the luminescent coat, for example, black).

The draftsmen, layout men, or loftsmen are provided with stylus-like tools, such as compasses and other scribing tools. These stylus tools cut through the masking coat and expose the luminescent coat underneath. Due to the hardness of the luminescent coat, the stylus tools do not penetrate the luminescent coat to the bare material. The result, in the line scribing, is a sharply contrasting line to the masking coat.

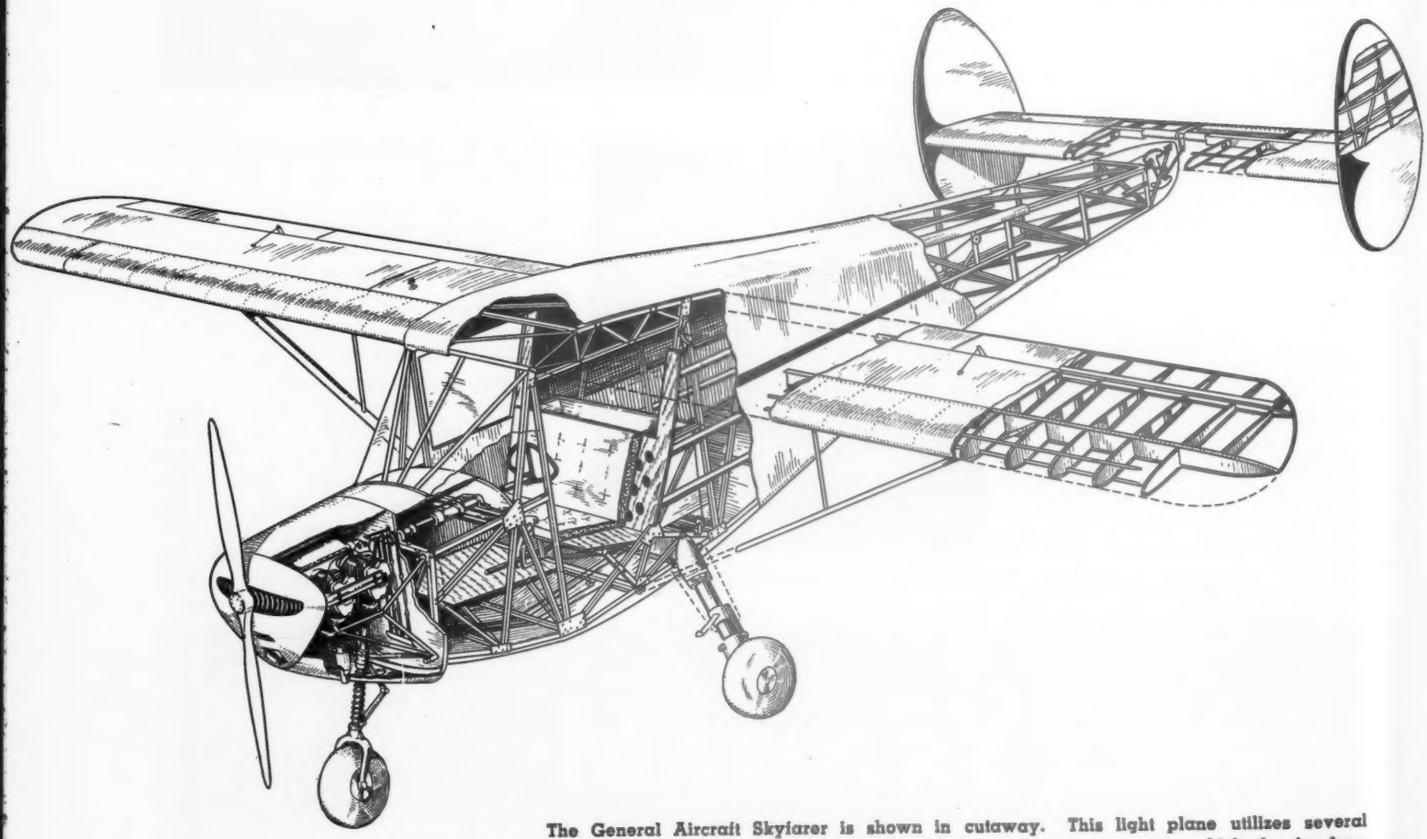
If the man laying the image makes an error of dratsmanship, this error can be quickly remedied by painting over the line drawn in error with material of the same substance as the masking coat. The "painting over" dries rapidly. When the layout and subsequent checking are completed, the luminescent lines are energized by exposure for a short time to incandescent, fluorescent, or any other artificial light or sunlight. The layout is then ready for reproduction use.

(Turn to page 172)

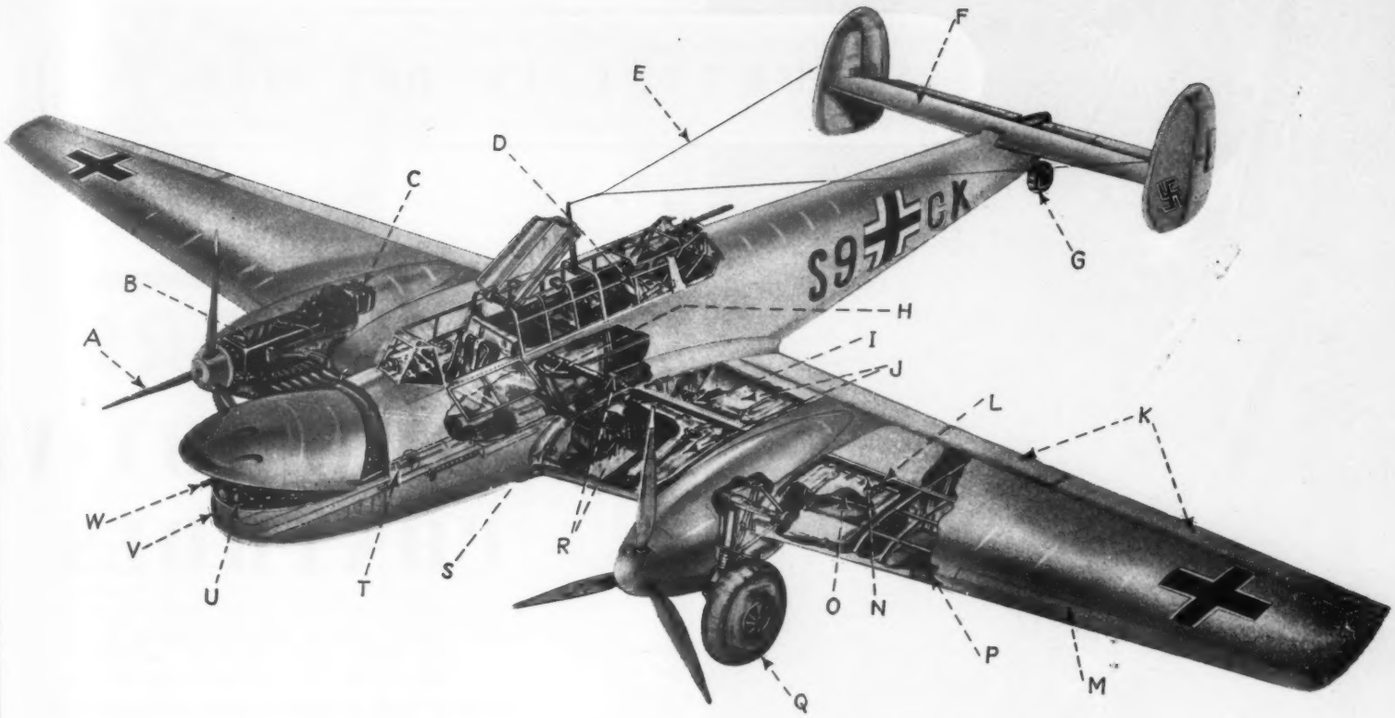
AVIATION SKETCH BOOK OF DESIGN DETAIL



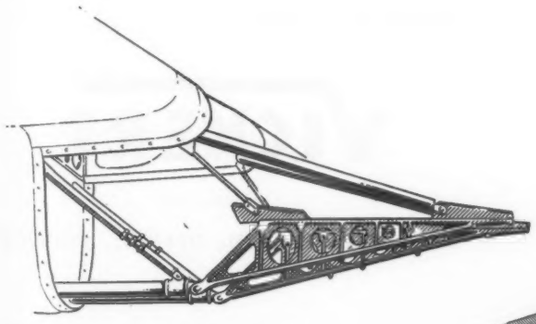
The new improved exhaust system now being used on the Luscombe airplanes is shown at right. The exhaust manifold is located at "A", while the exhaust from the engine enters at "B" and is expelled at "C". "D" is the cockpit heater inlet airscoop. This muffler has been designed so that it does not affect the back pressure of the exhaust or cause engine overheating. There are two mufflers, one on each exhaust.



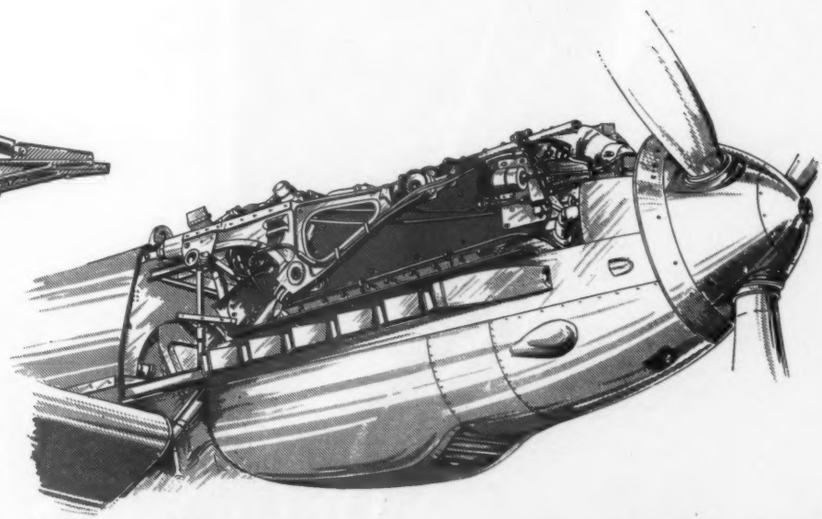
The General Aircraft Skyfarer is shown in cutaway. This light plane utilizes several unique features of construction. One of these is the novel way in which the fuselage is fastened together by Elastic Stop Nuts. Each member is easily replaceable and in case of necessity it can be changed in a minimum length of time and cost. The landing gear is attached by only three bolts, making this unit easily removable. The wing is constructed of a D-Spar to which are attached simply constructed ribs, cloth covered.



The Messerschmitt 110-C Multi-Purpose Fighter. "A" are the V.D.M. propellers. "B" is the Daimler Benz DB-601 engine, 1,150 hp. "C" is the oil tank. "D" is the gunner's seat. "E" is the radio antenna. "F" is the adjustable stabilizer. "G" is the non-retractable tail wheel. "H" is the navigator's seat. "I" is the rear wing fitting. "J" are the fuel tanks (self-sealing). "K" is the slotted type flap and aileron. "L" is the main spar 39 percent of chord (aft of leading edge). "M" are the automatic slots. "N" is the fuel tank (overload). "O" is the coolant radiator. "P" is the landing light. "Q" is the retractable landing gear. "R" is the wing main fitting. "S" is the wing front fitting. "T" are the 2 — 20 MM. cannon. "U" are the 4 comp. air bottles (gun charging). "V" is the gun camera. "W" are the 4 — 32 cal. machine guns (7.96 MM.).



Here's a side view of the engine mount on one of the Lockheed P-38 Interceptors before its Allison engine is installed.



The DB-601 engine installation in the Messerschmitt 109 is shown above. The main section of the engine mount is of forged magnesium alloy supported on a cantilever type mounting. Note the cannon in the nose and the exhaust stacks which do not utilize jet propulsion.

ASSURANCE IN THE AIR . . .

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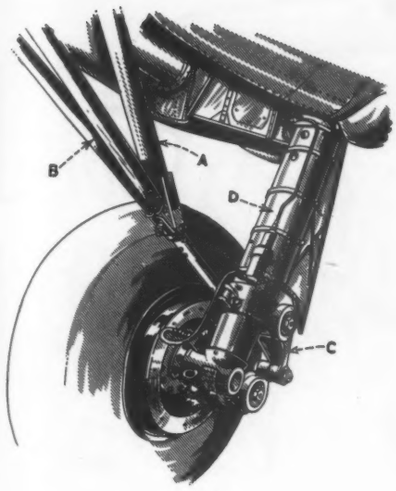
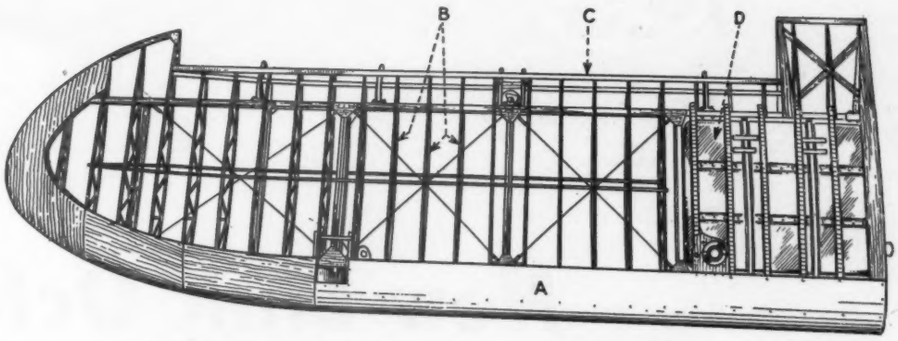
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

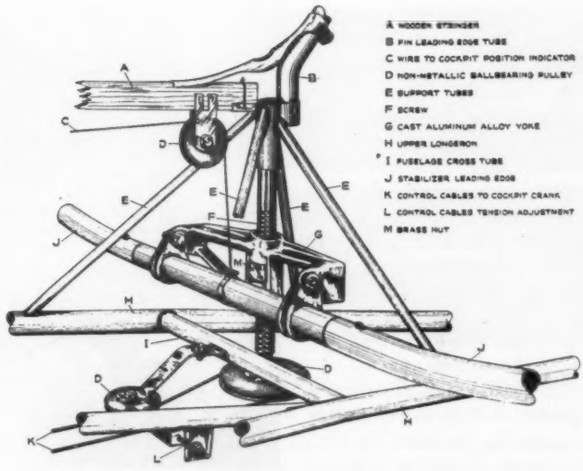


The landing gear retracting mechanism used on the Boeing Flying Fortress is shown above. "A" is the retracting screw mechanism for the landing gear. "B" is the drag strut, a welded assembly of steel tubing. "C" indicates the torsion links, which are aluminum alloy forgings. "D" refers to the oleo assembly, which consists of an oleo cover made of steel and an inner oleo cover made of steel and an inner oleo assembly. In operation, the Flying Fortress' landing gear is similar to the Stratoliner landing gear and is of the single oleo cantilever type, consisting of a strut and oleo assembly, torsion links, drag and retracting strut, wheel and brake. Retraction is normally accomplished by electric motors, but emergency manual operation is provided for each wheel separately. The oleo is 7.8 inches in diameter and has a stroke of a little over nine and one-half inches.

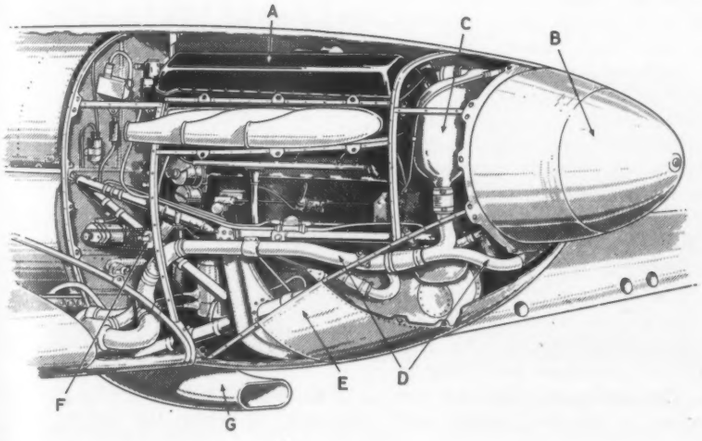
AVIATION'S SKETCH BOOK OF DESIGN DETAIL



The Beechcraft 18-S wing is mostly of wooden construction. The leading edge "A" is plywood covered and attached to wooden ribs "B". "C" is metal cap strip paralleling the leading edge of the aileron and flaps. "D" is the wing gas tank.


A WOODEN STRINGER
B FIN LEADING EDGE TUBE
C WIRE TO COCKPIT POSITION INDICATOR
D NON-METALLIC BALLBEARING PULLEY
E SUPPORT TUBES
F SCREW
G CAST ALUMINUM ALLOY YOKE
H UPPER LONGERON
I FUSELAGE CROSS TUBE
J STABILIZER LEADING EDGE
K CONTROL CABLES TO COCKPIT CRANK
L CONTROL CABLES TENSION ADJUSTMENT
M BRASS NUT

The stabilizer adjustment mechanism used on the Piper J3 Trainer and J5 Cruiser.



Features of the Rolls-Royce Merlin 1,030 hp. power plant installation in the Supermarine Spitfire are (A) cover plate for right bank of cylinders; (B) propeller spinner; (C) Glycol header tank; (D) Glycol pipes; (E) Oil tank; (F) Hand starter socket, and (G) Carburetor air intake. The Merlin gives 1,030 hp. on 87 octane fuel and considerably more on 100 octane.

Courtesy Flight Magazine

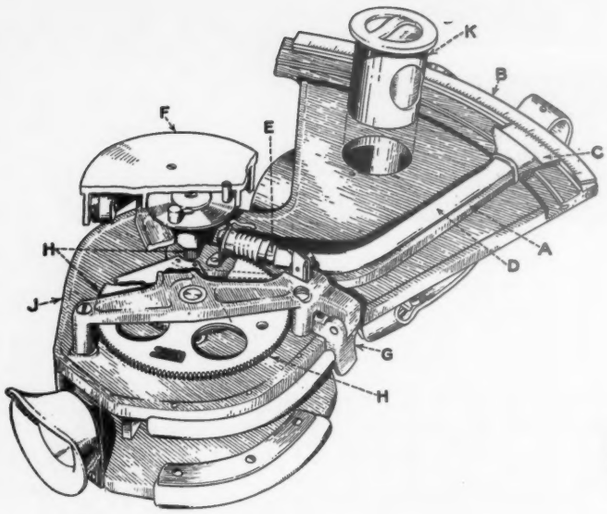


Fig. 1

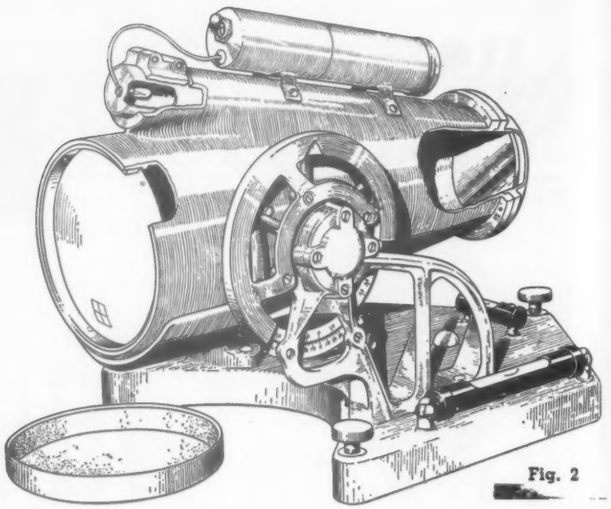


Fig. 2

New Link Octant and Collimator

TWO new instruments for aircraft use have been developed by Link Aviation Devices, Inc., of Binghamton, N. Y. and are being distributed by the J. V. W. Corporation of 1100 Raymond Boulevard, Newark, N. J. These are the Link Bubble Octant and the Link Collimator. Each instrument has been put through exhaustive tests by the Army and the Navy, as well as by the British on the ships being ferried across the North Atlantic. Following tests at Wright Field, the Air Corps ordered a large number of the octants* and a number of the collimators.

In addition to their value in military flying, it is predicted that these instruments will eventually be used by airlines and by schools teaching celestial navigation. The Weems school is already using this equipment.

The Link Bubble Octants were designed to fill the urgent need for low priced bubble octants which are both accurate and easy to use. These new instruments are designed to be light in weight, mechanically simple, rugged, compact in size, and shaped to the hand instead of having protruding handles and parts making them bulky and subject to easy damage. Particular attention has been paid to weight distribution so the instrument is neatly balanced when held in the hand. This combination of light weight and correct balance eliminates muscular exertion and makes accurate observations

easier to obtain. The Octants are so engineered as to permit rapid quantity production, the usual number of parts have been radically reduced, and essential parts made interchangeable.

A one piece frame of corded heat-treated aluminum casting makes a rigid and durably constructed instrument, unlikely to warp and strong enough to withstand shocks caused by rough handling.

The bubble chamber is quickly removable in a manner similar to the cartridge in a gun, so that different kinds or sizes of bubbles may be used to fit particular conditions prevailing at the time. The design permits the use of a slow or a sensitive bubble and choice of multiple or singular tubular types. In case of defect in the bubble element, a new one can be substituted in a few seconds.

Bubble lighting is accomplished by a self contained, quickly replaceable unit. This unit is simple in design and ruggedly built and is not dependent on any outside electrical systems. The lighting unit can be removed and used as a flashlight. The scale has its own lighting system. A type of diffusing filter is used in the bubble lighting system which materially improves the visibility of second and third magnitude stars. Under conditions of poor visibility or when taking sights by direct vision on second and third magnitude stars, the bubble disc is made visible on the index glass with a minimum of illumination.

The Link Octants are built in two models, the C-8 without Averaging Device, weighing 2 lbs. 3 oz. and Model C-9 with Averaging Device, weighing 3 lbs. 2 oz.

Model C-9 Octant

The following features are indicated in Fig. 1:

A—Arm
B—Arc (scale)
C—Vernier
D—Lucite Rod
E—Bulb
J—Cast Aluminum Frame
K—Bubble Chamber

The Arm (A) is rigidly pivoted to the axle, to which the Index Glass L

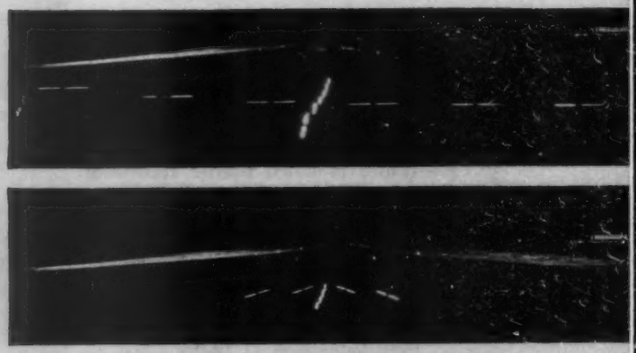
* This instrument is now officially listed as a sextant by the Army.

LATEST IN LIGHTING

SAFEGUARDS NATIONAL AIRPORT TRAFFIC

One of the outstanding features of the new National Airport at Washington, D. C., is the Westinghouse lighting and traffic control system—the newest and most complete in the world. This system is the result of close co-operation between Westinghouse lighting engineers and the Civil Aeronautics Administration to make economical airport lighting equipment available to the Nation's airports and to standardize lighting methods. The first complete installation at the new National Airport is serving as an efficient model for future fields. Here, Westinghouse equipment speeds traffic day and night, and provides the utmost in safety. For example, on approaching the new National field——

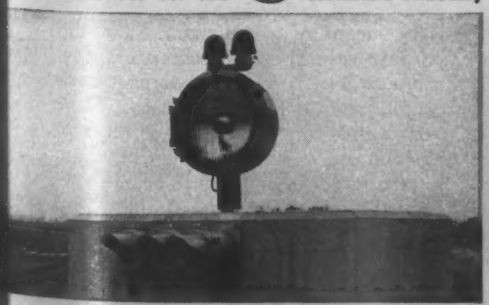
——a pilot is guided by identification letters flashed by the Westinghouse auxiliary beacon, above. Next, clear cone-type Westinghouse boundary lights outline the field. As pilot brings his plane over the field——



——a large red cross flashes on at each end of one of the runways, as shown in the upper illustration, clearly identifying the runway to be used. Next, a green arrow flashes at one end of the runway giving landing clearance and direction. Note above. Then, as the pilot brings his plane around for landing, two powerful Westinghouse floodlights are turned on at the approach end of the runway permitting the pilot to land safely with the light at his back. On these floodlights——

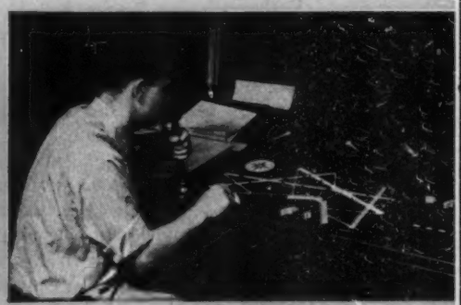
Westinghouse

Time-Saver for the Aviation Industry



——note above, a 10° lens fans the light out horizontally and concentrates it vertically. Guiding the pilot along the runway are Westinghouse contact lights equipped with brightness control that adapts intensities to weather conditions. Blue taxi lights guide the pilot from runway to unloading ramp. Taxi lights, contact lights and range lights are of the same——

——Westinghouse universal, flush-type marker light construction shown above. Note Fresnel lenses that pancake light horizontally preventing glare. These lights are also used for traffic lights where taxi strips cross runways. Another system of traffic lights gives pilots clearance for take-off. Note traffic lights in base of floodlight illustrated at left——



——when the green light shows at the far end of the runway, all is clear. All field circuits at the Washington, D. C., National Airport are at the finger tips of the control tower operator stationed at the Westinghouse control panel, above. Pre-set switches permit operation of lights to be set up in advance.

T-94434

(Fig. 3) is also rigidly attached, so that a movement of the Index Glass is indicated on the Arc (B) which is graduated to 30 sec. divisions. The Vernier (C) indicates 2 sec. divisions of the scale. When the reading is between 0 and 30 sec., the lower set of Vernier figures is used. Between 30 sec. and 60 sec. the upper set of figures is used.

With practice, rapid and accurate readings of the Vernier may be made.

The Battery (M) Fig. 3 in a case with the light is held in place by friction and may be withdrawn easily for renewing the battery or for use as a reading light.

There are two Sun Dimmer Glasses (N) Fig. 3 which are adjusted to control the glare of the sun. For observation the Dimmer Glasses should be approximately perpendicular to the line of sight to the sun.

The Bubble Chamber (K) fits into the Octant by a good press fit and is accurately positioned by means of a dowel pin and held in place by a friction spring. Any of several easily interchangeable bubble assemblies may be used. The bubble itself is in a strong tightly sealed chamber. The use of a fixed type bubble prevents the loss of time required to adjust the size of an adjustable type bubble.

The C-9 Octant is similar in principle and operation to the C-8, but is equipped with an Averaging Device as indicated in Fig. 1:

F—White moulded plastic recording drum which also actuates the index glass and arm.

G—Trigger and altitude marking feature.

C—Cover for averaging feature.

H—Gears and Quadrant for transmitting motion of Index Glass to recording drum.

In the C-9 Octant, as in the model C-8, the Index Glass (mirror) is solidly pinned to the main axle to which also is pinned the arm which carries the Vernier scale. Consequently, there cannot possibly be any lost motion between the Index Glass and the scale. The Vernier scale is illuminated by the bulb E through the Lucite roll D. The recording drum (F) is geared to and drives the arm (limb) along the scale. The gear train between this drum and the arm utilizes a double spring loaded gear in such a manner that no back lash can exist. Any possible wear as a result of long periods of service also is compensated for by the above gear so that at no time can back lash or lost motion develop between the recording drum and the integral Vernier arm and mirror.

The recording drum is made of a material unaffected by water or temperature, and is mechanically strong. The material is such that the marks are easily recorded yet can be quickly cleaned for re-use. The recording drum is removable so observations may be taken on several stars using a different recording drum for each. These later can be replaced on the Octant and the Median or Average reading taken when the navigator has more time and is located at the navigator's table where lighting and working conditions are better.

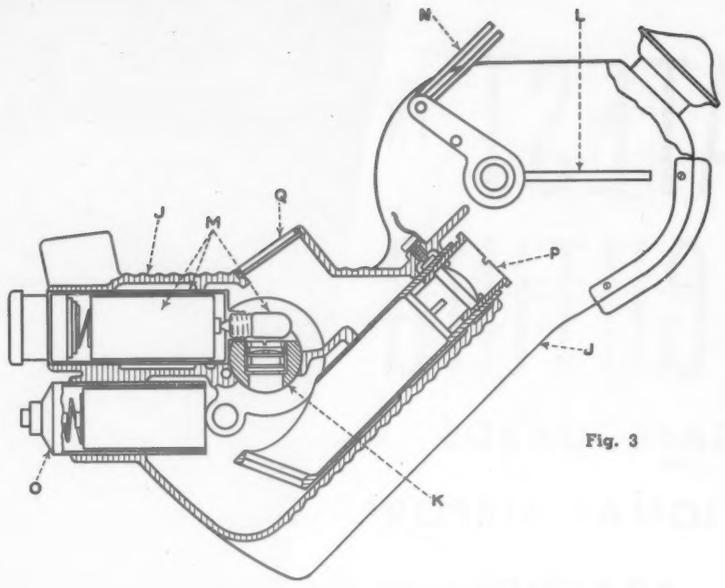


Fig. 3

In selecting an octant or sextant the following facts and principles should be kept in mind. Accuracy of observation even with observer on the ground usually varies one to three miles. The slight balancing motion of a person standing, or even the heart beat causes the bubble to move slightly. Observations in flight or in a boat are affected by accelerations and may vary up to fifty or a hundred miles or minutes of arc, depending on the amount of acceleration.

Although errors in single observations are large, *an average of ten or more* observations ordinarily reduces the resultant error to *within five miles.*

Adjustment

If through mishandling or accident the Link Octant gets out of adjustment, relatively simple means for readjusting it have been incorporated in its design.

Since the bubble is carefully adjusted to the horizontal at the factory and locked in position, it is unlikely that further adjustment to it would be needed. Provision for such adjustment is made, however, and can later be utilized as it was originally done at the factory.

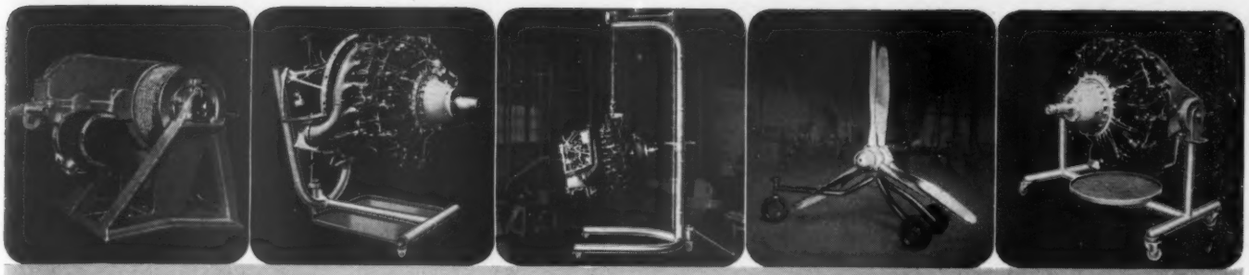
The only remaining adjustment to make is for scale error. This can be done readily by setting the Octant up on a tripod and centering any object of *known altitude* in the bubble, then adjusting the Vernier scale to indicate that known altitude. There are two methods of accomplishing this. One is by making use of the natural (water) horizon with the Octant held within a foot or so of the surface of the water and checking so that the reflected horizon line cuts through the center of the bubble with the scale at zero. The other method is by using a celestial body at a precomputed altitude and time and checking so that the indicated altitude, suitably corrected, agrees with the computed altitude. Using this latter method, stars must be selected with a very small local hour angle so that their altitude is changing very slowly if at all.

A much more handy and in general more accurate method of checking index error is by use of a collimator such as the Link Collimator which may readily be set to any desired altitude. Simply set the Link Collimator to any altitude (say 30 degrees even), center the Collimator "star" in the center of the bubble, and adjust the Vernier scale of the index to indicate exactly 30.

The Link Collimator

The simplest way to obtain an accurate test of bubble sextants or octants is by means of a collimator. For this purpose several small collimators (approximately 2 in.) mounted in a horizontal position have been used. These permit checking the octant at the zero position only and consequently are limited in use in addition to being somewhat difficult to operate.

Because of the disadvantages of existing test units, the Link Collimator was designed to facilitate checking, testing and adjusting the Link Octant at the factory. This unit is now available for general use.



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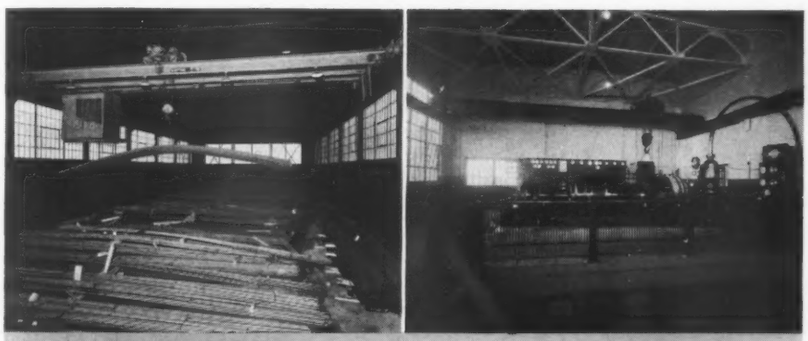

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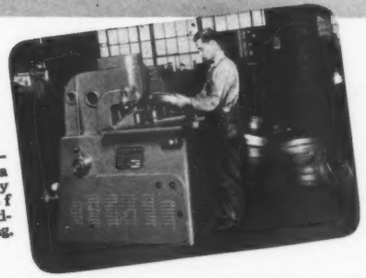

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LEADERSHIP

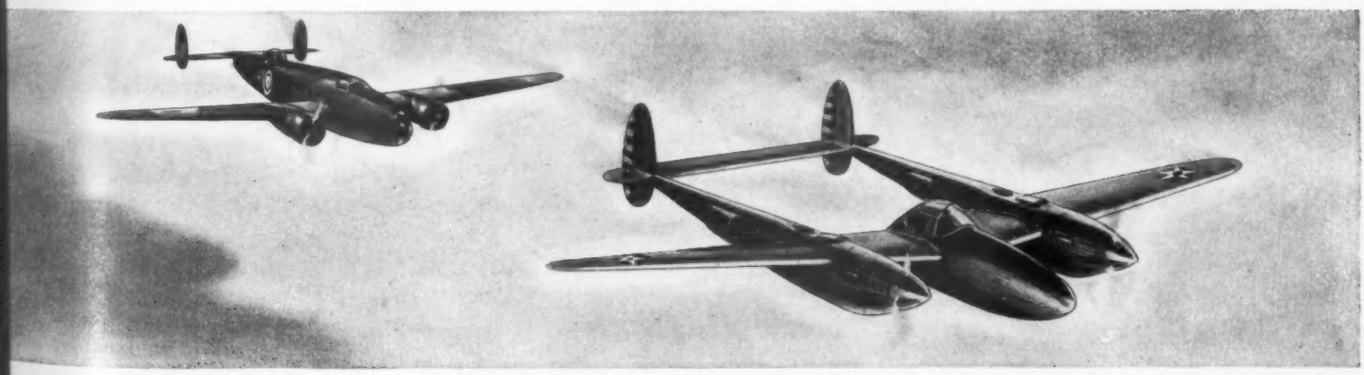
ip in Design

Lockheed design is proved design! It is an aerodynamic sleekness that makes high speeds for large airplanes both efficient and profitable. Its rugged strength and built-in stamina have made all-weather operations practical. And its tip to tail thoroughness has earned a reputation of dependability and high performance across six continents.

Lockheed was not originated as a manufacturer of military aircraft... but when the nations of the world called upon this organization for such airplanes, Lockheed's advanced designs were easily adaptable to wartime needs.

The Hudson bomber, transformed almost overnight from the Lockheed 14... has proved itself under brutal punishment in the hands of the Royal Air Force. Designs have already been completed on a larger bomber, adapted from the Lodestar transport, offering higher speed and greater range. And the "Lightning" interceptor pursuit, now in quantity production, has no equal among fighting airplanes.

These airplanes are out in front in their fields. They are leaders wherever they fly because they were designed to lead. They are versatile... adaptable and whatever their purpose, they *carry greater loads at higher speeds at lower costs.*



daptability and stamina are predominent in the design of e Hudson bombers. No job is too tough for them to under- ke. Long range reconnaisance... aerial photography... bomb- g... actual combat are all in their day's work with the R.A.F.

The Lockheed "Lightning" interceptor pursuit was designed for great speed and fire power. It is universally accepted as one of the fastest airplanes in the world. In simulated combat it has out-climbed and out-flown other airplanes of all types.

LOOK TO *Lockheed* FOR LEADERSHIP

OCKHEED AIRCRAFT CORPORATION • BURBANK, CALIFORNIA, U S A

nted in U.S.A.

HERE'S YOUR "All-Weather" COMBINATION!

Aircraft Radio Group AVTRL-1
Transmitter, Receiver and Loop

FOR SAFETY IN FLIGHT, any radio equipment is better than none at all. But the *best* is better still! For only the best can be relied on under toughest flying conditions in the worst weather . . . and *that's* when you need your radio equipment most of all!

In radio, "best" means RCA. It's as simple as that. No other manufacturer possesses RCA's rich resources of background, facilities and experience. Excellence of RCA engineering and design, combined with RCA's large-scale mass production economies, gives you extra quality at no extra cost.

This RCA combination is a good example. Matched units, embodying many exclusive RCA features, they're tailor-made for private flying —at a price any private flyer can afford. Ask your RCA Aviation Distributor for complete data, or write direct.

RCA BROADCAST EQUIPMENT
From microphone to antenna

JUST A HANDFUL—yet this RCA Aviation Radio Receiver, Model AVR-100, is more efficient, sensitive and rugged than many a much larger receiver! Not even a cubic inch of space is wasted in its design and construction—only genuine RCA engineering could give you so much in so little . . . *for* so little!

NEW RCA 2-FREQUENCY AIRCRAFT TRANSMITTER, Model AVT-110, shown with RCA All-Position Microphone Model AVA-31A. For the *first* time in any aircraft transmitter, you can have the stability of *permeability tuning.* Single switch adjusts transmitter to antenna, whether trailing or reeled in . . . and selects either 3105 or 6210 kilocycle band. Universal 10-G shock mountings.

Other AVTRL systems available with the AVR-101 one band Aircraft Receiver. Available with dry battery or storage battery power supplies.

RCA DIRECTION-FINDING LOOP ANTENNA . . . Model AVA-122. Full electrostatic shielding, to reduce annoying precipitation static . . . makes the null point easier to find, even when the station's signal is low and the noise-level is high.

RCA for Aviation Radio

RCA MANUFACTURING COMPANY, INC., CAMDEN, N. J.

A Service of the Radio Corporation of America • In Canada: RCA Victor Co., Ltd., Montreal

CAA and the Airplane Buyer

The work of the C.A.A. factory inspector brings the buyer a better airplane

By Donald R. Moulton, *C.A.A. Factory Inspector assigned to Interstate Aircraft and Engineering Corp.*

BUYING an airplane, to most of us, is serious business. We make our selection from among those planes that meet our requirements and pocketbook, add such accessories as will make our ship most useful, and trust in the reputation and integrity of the manufacturer that the plane will hold together long enough to pay itself out and return a reasonable profit.

Few people know that behind the assurance of the manufacturer that a plane is airworthy is a bond of confidence backed by the United States Government.

The plane you purchased may bear manufacturer's serial number 6 or 600, but in either case the following procedure of C.A.A. inspection holds true.

The experimental prototype of your plane has been subjected to the most severe and critical examination and test. Drawings and stress analysis were thoroughly checked, construction minutely examined and critical components loaded with weights in excess of loads and strains encountered in flight.

Having passed these requirements, the plane is subjected to an exhaustive series of flight tests to determine that flight characteristics of the model are good and that no dangerous operating characteristics exist.

After approval of the model, the Civil Aeronautics Administration assigns a resident factory inspector to those plants where planes are to be built. First duties of the resident inspector are to perform inspections of the factory organization, workmanship, methods, material and facilities to determine whether they meet the requirements for a Production Certificate. This applies to aircraft construction, aircraft engines, aircraft propellers, and to some aircraft components and accessories.

For example, the inspector assigned to Interstate Aircraft & Engineering Corporation at El Segundo, California, where Interstate CADETS are built, encountered several features of construction that were without precedent. Although the CADET is a conventional highwing tandem trainer in the low horsepower range, it embodies such new developments as the Interstate patented Fabriclip, used throughout the entire plane to replace rib stitching. The fact that this was a completely new idea meant a great amount of special testing. The capstrips of the ribs were of a new type, and a different order of applying tape over the ribs necessitated many additional tests to prove the adequacy of this new manufacturing process. Once completely tested and approved, however, only routine inspection is required on all subsequent planes built under the terms of the same Type Certificate.

The resident inspector is further required to inspect aircraft, aircraft engines and aircraft propellers which are later to be presented to the Administration for type tests while the aircraft, aircraft engine or propeller is in the process of manufacture in order to determine whether or not the construction is airworthy and in accordance with Civil Air Regulations.

He is to inspect factories which are engaged in producing aircraft, engines and propellers under Approved Type Certificates in order to determine whether the terms of the Certificates are being fulfilled.

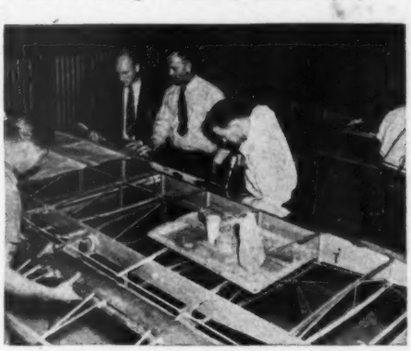
Special investigations are conducted when service troubles have resulted on previously licensed aircraft. The cause of the trouble is determined and it is the duty of the inspector to see that proper correction is made.

To determine that the factory holding a Production Certificate continues to remain eligible for such Certificates by reason of maintaining suitable facili-

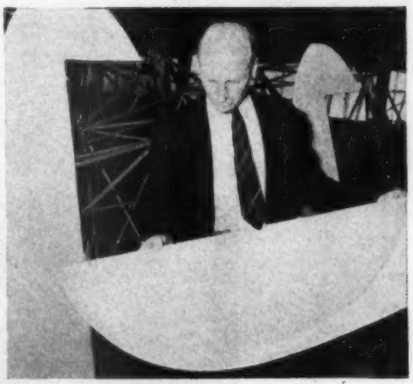
(*Turn to page 186*)

The author inspecting raw materials as they are piled in the Interstate stockroom.

The C.A.A. inspector moves through the plant carefully watching fabrication.



Wing inspection is an important part of every factory inspector's responsibility.

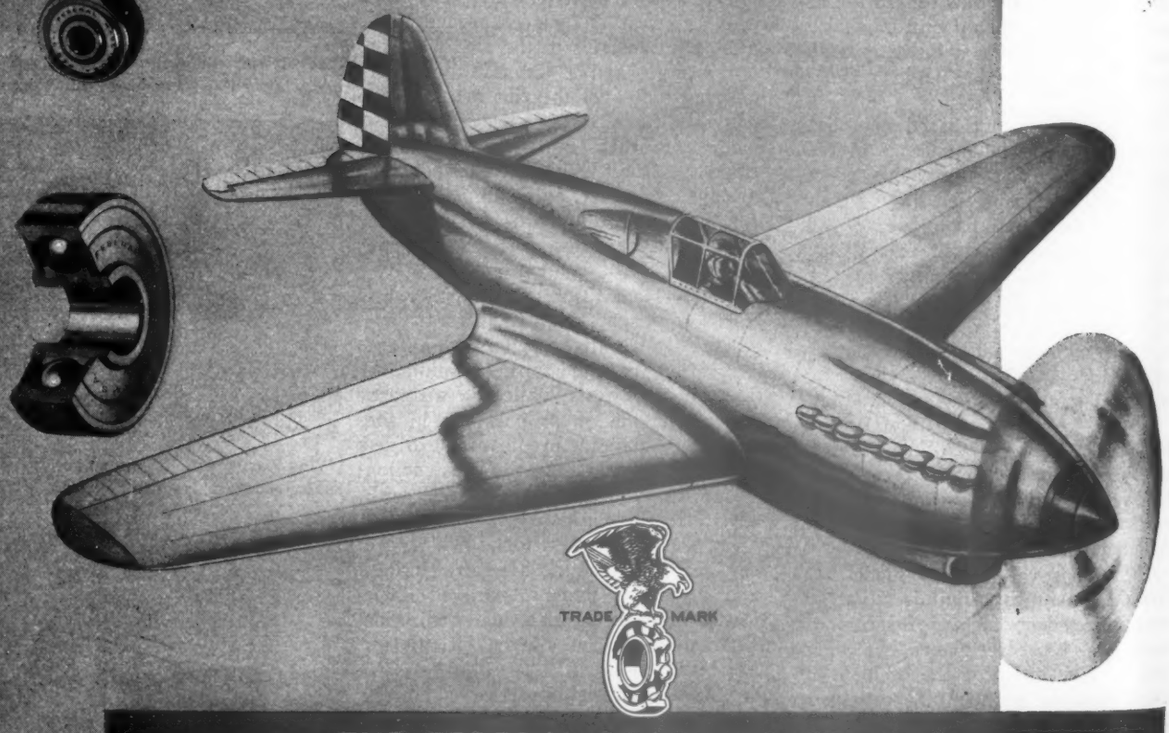


After sub-assemblies are covered with fabric the work is carefully examined.

FEDERAL

Aircraft BEARINGS

QUALITY and PRECISION ball bearings are essential to the National Defense Program. The FEDERAL plant -- working to capacity -- is producing its full quota of fine ball bearings to meet the constantly increasing demands of the aircraft industry.



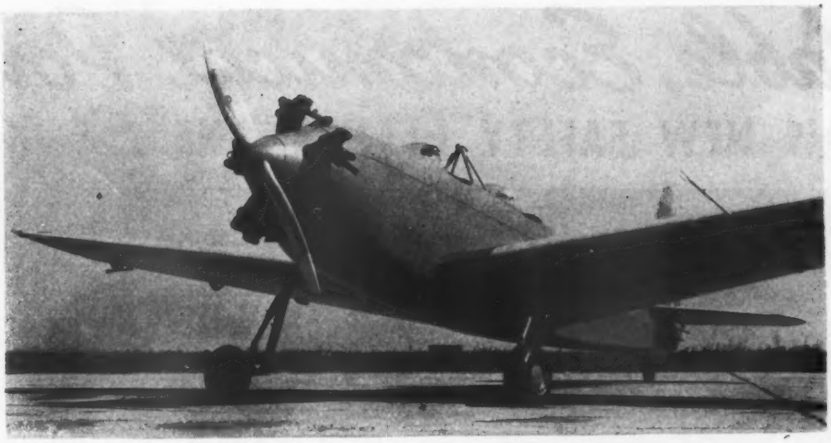
TRADE MARK

THE FEDERAL BEARINGS CO., INC.

Makers of Fine Ball Bearings

POUGHKEEPSIE, N. Y.

Detroit Office: 2640 Book Tower • Cleveland Office: 402 Swetland Building
Chicago Office: 902 S. Wabash Ave. • Los Angeles Office: 5410 Wilshire Blvd.



The new Howard advanced trainer has a stream-lined nose and greater power with the 160 hp. Kinner installation. It has much better performance than earlier Howards.

Flying EQUIPMENT

New Howard Trainer

Increased performance featured for advanced CPTP courses in the new DGA-160, an improved model which is to supersede previous trainer currently used by operators

THE latest Howard training plane, Model DGA-160, which has been designed especially for secondary and instructor courses of the Civilian Pilot Training Program, is of higher horsepower and will supersede the DGA-125 currently in use.

Powered with a Kinner R-5 160 hp. dual ignition radial engine, maximum speed is 120 m.p.h., and at 75 percent power the ship cruises at 109 m.p.h. with an endurance of 2¾ hrs. Rate of climb the first minute after take-off is 900 ft. and the service ceiling is 14,000 ft., climbing to 5,000 in 6½ minutes. The take-off run is 725 ft. and landing speed 57 m.p.h. Cruising range is 300 miles.

Streamlining of the nose is increased by use of the Kinner engine. The fuselage, as in the DGA-125, is constructed of chrome molybdenum steel tubing, oxy-acetylene welded. Side panels are quickly removable from the rear of the after cockpit forward to the nose, and a removable panel makes the tailwheel assembly accessible. Wings, stabilizer and fin are spruce structured and covered with mahogany plywood, fabric and a plastic preservative. Wing tips are detachable, the stabilizer is fixed and trim is regulated by a tab on the elevator.

Landing gear and tailwheel shock absorbers are spring-hydraulic. The tailwheel is steerable from the pedals with automatic throw-out device at 45 degrees, right or left, which combined with the wide tread gear of about 9½ ft. is practical proofing against ground looping. All controls are equipped with ball and roller bearings.

Both cockpits are provided with airspeed indicator, compass, altimeter, tachometer, fuel gage, and oil pressure and temperature gages. A communications tube is installed between front and rear cockpit.

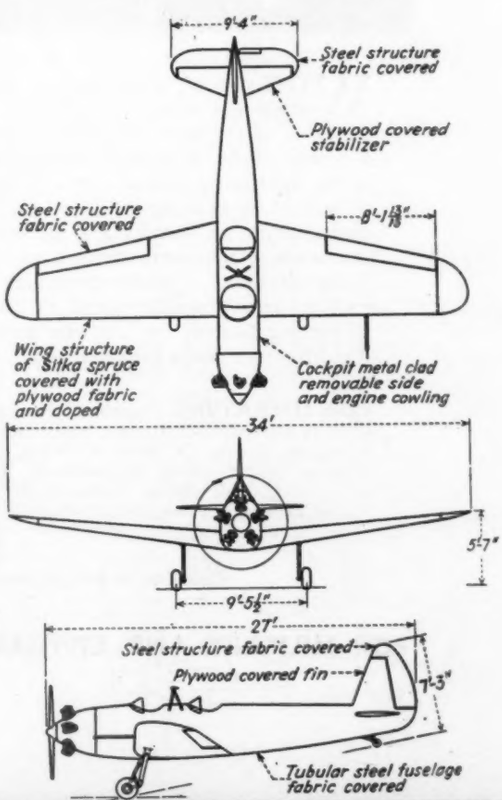
Performance and specification figures on the Kinner powered Howard DGA-160 Advanced Trainer are as follows:

Performance

Maximum speed	120 m.p.h.
Cruising speed (75% power)	109 m.p.h.
Landing speed	57 m.p.h.
Cruising range	300 miles
Endurance (75% power)	2¾ hrs.
Climb 1st minute after take-off	900 ft.
Climb to 5,000 ft.	6½ min.
Take-off run	725 ft.
Service ceiling	14,000 ft.

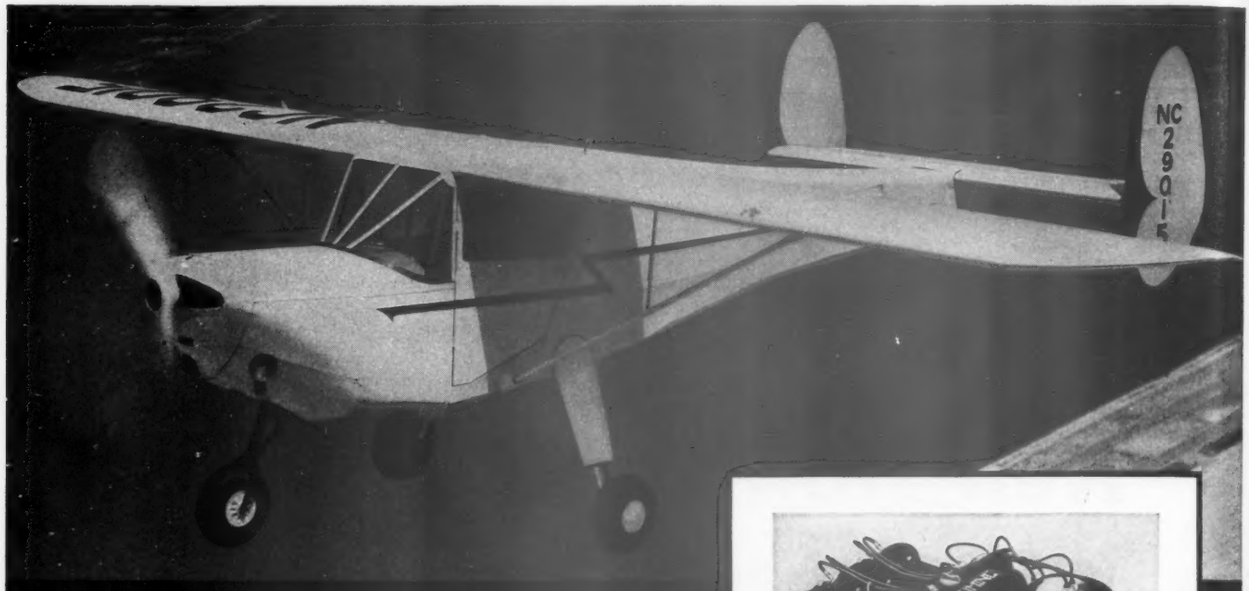
Specifications

Gross weight	2,200 lb.
Empty weight	1,525 lb.
Wing area	179.50 sq. ft.
Ailerons	19.10 sq. ft.
Stabilizer	15.30 sq. ft.
Elevator	14.30 sq. ft.
Rudder	6.71 sq. ft.
Fin	8.55 sq. ft.



Dependable, Economical Power

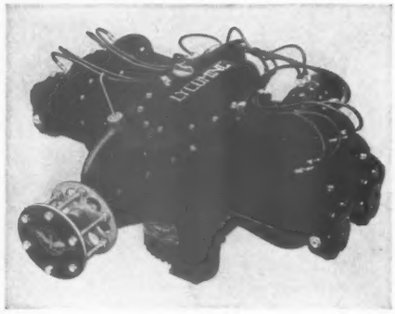
FOR AMERICA'S NEW SAFETY PLANE...THE "*Skyfarer*"



GENERAL AIRCRAFT CORPORATION

Chooses the

LYCOMING *Geared "75"*



BLUE RIBBON ENGINES

Lycoming offers you the widest choice of power in horizontally opposed engines offered by any engine manufacturer! The famous Lycoming *Geared* 75-horsepower engine is illustrated. Other blue ribbon four-cylinder models are available in 50, 55, 65, 100 and 125 horsepower and six-cylinder models in 150 and 175 horsepower. All models have provision for mechanical or electric starter and accessory drives.

WITH design, construction and performance based upon the sound foundation of safety, the manufacturers of the new "Skyfarer" looked to Lycoming for a power plant of proved dependability. Such an engine is the Lycoming *Geared* "75." The higher piston speeds permitted by gearing produce amazing economy . . . fuel consumption as low as 4½ gallons per hour . . . extra smoothness, maintenance of revs in quicker take-off and faster climb . . . greater propeller efficiency, developing 75 h.p. at a propeller speed of only 2015 rpm! Fly the Lycoming *Geared* "75" in the new "Skyfarer" and feel the difference *geared* power makes.

FREE LITERATURE: Completely descriptive literature on Lycoming 50 to 75-horsepower light-plane engines may be obtained from leading light-plane dealers. Or write Lycoming Division, Department A91, Aviation Manufacturing Corporation, Williamsport, Pennsylvania, U. S. A. . . . Cable address: Aviatcor. (If you wish literature on the higher horsepower horizontally opposed engines, please specify.)

YOU CAN RELY ON

LYCOMING

50 to 300 H.P.

Engines

Contractors to the U. S. Army and Navy

FOR MILITARY AND CIVILIAN TRAINERS ★ FOR PRIVATE AND COMMERCIAL PLANES

Nazi Nemesis

FOREIGN EQUIPMENT

Britain's deadly night interceptor, the Bristol Beaufighter

FORMIDABLY armed with four cannon and six machine guns, the most powerful armament of any fighting plane in the world, the Bristol Beaufighter literally blows to pieces Nazi raiders over England.

A large, two-place, twin-engined plane, weighing 21,000 lb. loaded, the Beaufighter has a range of 1500 miles and a top speed of 330 m.p.h. at 14,000 ft. Despite its size and weight, it is said to be capable of a short take-off, fast climb and exceptional maneuverability. Power is supplied by two Bristol "Hercules" III engines.

The four 20 mm. Hispano-Suiza shell guns are concentrated in the fuselage, while the six Brownings are installed in the wings. Designed primarily for service in the night fighter squadrons of the R.A.F., its terrific fire power makes the most of the fleeting glimpses of enemy aircraft afforded in the dark, and it is officially reported that German warplanes have been blown to bits in midair after a couple of bursts from the Beaufighter's armament.

Developed from the Beaufort bomber, which has been making successful torpedo attacks on Axis shipping, the Beaufighter is an all metal, midwing monoplane with accommodation for pilot and observer. Owing to the different function which the Beaufighter has to perform, the nose is shorter than the Beaufort's and, instead of the "raised deck" of the torpedo bomber, terminating in a gun turret facing aft, the Beaufighter has a projecting turret facing round the compass. Wing span is nearly 58 ft. and overall length a little more than 41 ft. A trap door in the underside of the fuselage is so designed that when it opens a "dead air" region is created, thereby enabling the crew to bail out no matter what speed the plane is doing at the time.

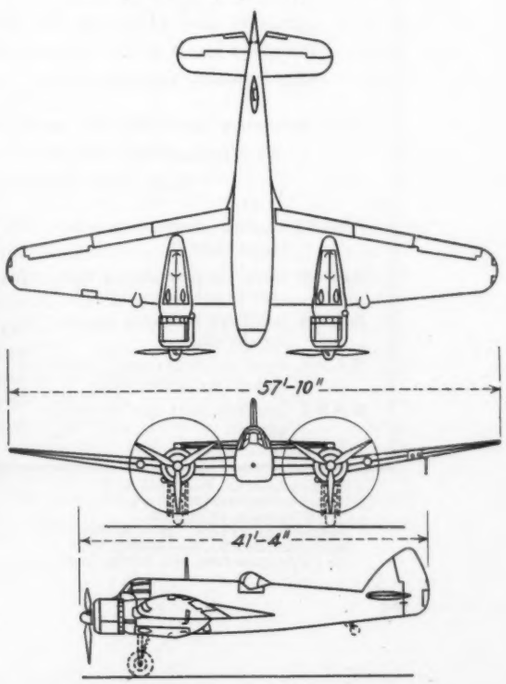
Equipment is said to be unusually complete, including navigation, identification and formation flying lights, landing flares, oxygen apparatus, motion picture camera mounting, first aid outfits, and even an axe. The Lorenz beam approach equipment, used for night landing without the aid of flood-lighting on the field, is reported by one authority in this country to have resulted in more casualties in crack-ups than in combat. However, as it remains a part of the Beaufighter's equipment, it may be assumed the British are not merely being prodigal with their pilots and planes.

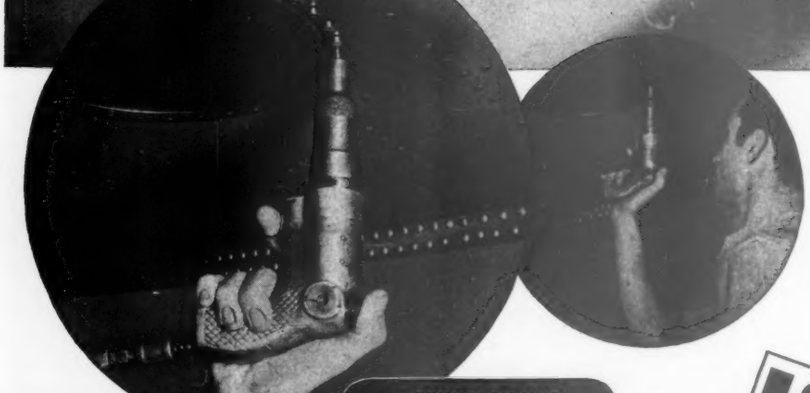
The 14 cylinder, two-row, Bristol "Hercules" III engines are equipped with two-speed superchargers and develop 1400 hp. each at take-off. An aircooled radial engine, it weighs 1,680 lb. and has an overall diameter of approximately 52 in. The two-throw, three-piece, counterbalanced crankcase of the "Hercules" is machined from aluminum alloy forgings having their joint faces on the cylinder center lines. The three pieces are held together by two sets of through bolts, the rear set extending back for the attachment of the supercharger. Cylinders have steel

(*Turn to page 172*)

Photos British Combine

The twin-engined Bristol "Beaufighter", from the same stable as the "Beaufort" torpedo bomber, tracks down and destroys Nazi night raiders.





THE PHILLIPS RECESSED HEAD SCREW CLINGS TO THE TAPERED DRIVER— AND PREVENTS SLIPPAGE

It's easy to reach awkward positions *with one hand* when using Phillips Screws. And they *set uniformly tighter,* resisting high-speed vibration.

NORTH AMERICAN AVIATION, INC., SPEEDS PRODUCT DELIVERIES WITH PHILLIPS SCREWS

Straight and clean as the lines of the B-25 Bomber itself is the fast, safe power driving that speeds its assembly.

You, too, may save time and money—as much as 50%!— by eliminating "old-fashioned fastening" from your assembly line

PHILLIPS Screws *cost less to use* because they

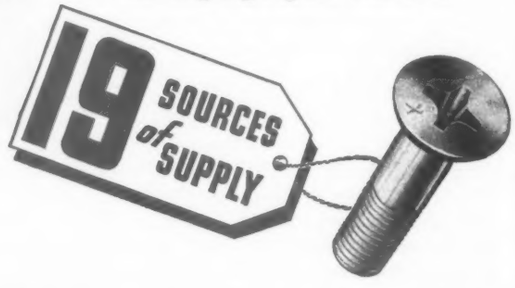
SAVE time by permitting fast, safe power driving

SAVE workers' strength by easier driving

SAVE cost of lost-time accidents and refinishing

SAVE burred, split and wasted screws

War or peace, the Phillips Screw gives you faster driving, stronger assemblies, lower costs. And Phillips Screw manufacturing capacity assures prompt deliveries. Write to any of the firms listed below.



PHILLIPS RECESSED HEAD SCREWS

WOOD SCREWS · MACHINE SCREWS · SHEET METAL SCREWS · STOVE BOLTS
SPECIAL THREAD-CUTTING SCREWS · SCREWS WITH LOCK WASHERS

U. S. Patents on Product and Methods Nos. 2,046,343; 2,046,837; 2,046,839; 2,046,840; 2,082,085; 2,084,078; 2,084,079; 2,090,338. Other Domestic and Foreign Patents Allowed and Pending.

Speed Product Deliveries by Cutting Assembly Time

American Screw Co., Providence, R. I.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
The Charles Parker Co., Meriden, Conn.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterbury, Conn.
Shakeproof Lock Washer Co., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N. H.

Aviation RADIO

Dialing the Air Waves with Craig Walsh

Speculating on the British Radiolocator

When an invading force of night-flying enemy bombing planes is damaged by the defenders to a decisive degree, we have an occasion of great importance. The American press, both newspapers and magazines, has taken care to see to it that the public knew that this is what happened in England and that it was not just a coincidence. Some time ago it was announced by the British government that the long-rumored secret weapon against night bombers was an actuality and that it was a locating device which spotted enemy aircraft and plotted their courses before they reached the coast of England. Naturally, this left the invading force wide open to attack by defending planes long before they approached their target.

Other than to say that the new instrument is a radio device, that it operates in the microwave portion of the frequency spectrum, and that it borrowed from television technique, very little information has been given concerning its construction and operation. Speculation has built very strongly upon this data using a knowledge of the characteristics of extremely high frequency radio waves (of the order of 1000 megacycles and higher) which are well known, and of the operation of a television system.

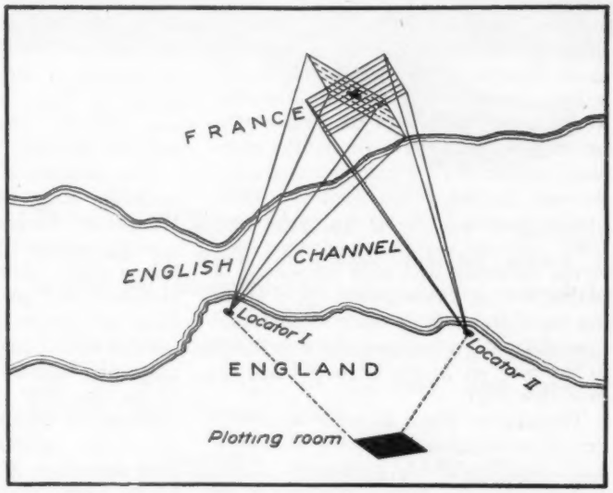
First of all, it is known that microwaves are reflected from objects the same as light waves are. Therefore, a searchlight could be replaced with a microwave transmitter and a radio receiver used to pick up any reflected energy to indicate the presence of an object such as an airplane in the microwave beam. This method has the advantage that the enemy airman is unaware that his presence has been discovered. This, however, would not be the startling secret weapon now in use because it would be only as useful as a single searchlight with the advantages of greater range and being unknown to the enemy.

All further elaboration of the design and operation of the radiolocator must be considered as pure speculation by your editor and is presented only to give a general idea of how such a device might be made to operate.

In developing the idea of a radiolocator it would be well to build upon the characteristics of light waves with which we are familiar and later switch over to a system using radio waves. As the first speculation consider the effect of lighting the entire area of the sky. We would have the effect of daylight and all objects would be visible to the eye, possibly with the aid of a telescope. This, however, is a physical impossibility. Next, consider the effect of a narrow beam of light passing through the sky, very rapidly and to such an extent that each portion of the sky is lighted momentarily. If this process is repeated at very short intervals, the effect on the eye will be the same as if the sky is continually illuminated and all objects within the range of the light beam will be visible. This is also physically impossible.

The foregoing paragraph, while describing impossible or at least highly impractical methods, point the way to an electronic system for the location of enemy aircraft. It is known that a microwave radio beam will be reflected by an airplane or anything else in its path. It is also possible to radiate a microwave in a narrow beam. (This would undoubtedly be one of the major problems.) Thirdly, the direction of radiation of such microwave beams can be rapidly changed in any desired manner. Making use of these phenomena together with some television technique, a workable locating system could undoubtedly be devised. This is a good point to note that no new principles are involved and that scattered throughout the literature of radio and physics of the last five or six years there have been a not inconsiderable number of articles devoted to the location of aircraft using radio waves. One such article appeared in the September 1935 issue of *Electronics* and was entitled "Microwaves Detect Aircraft." This is mentioned only to indicate that the chances are that no radically new fundamental law of nature has been harnessed, and not to belittle the new instrument. Rather, the development of the radiolocator represents the brilliant application of known methods to the

(*Turn to page 140*)



Map showing the locations of two radiolocators and how the locations of German planes while still over France can be determined.

International

British girls work with men in detection posts, plotting Nazi planes movements.

Aviation's Accelerated Production

By Selig Altschul

THE ability to produce aircraft in volume is the key to profitable operations in the aircraft industry today. This point—long emphasized in this column—is reflected in the semi-annual reports for 1941 released by leading aircraft builders.

Despite reduced profit margins and increased taxes, certain aircraft manufacturers have reported the largest earnings in their history. Consolidated Aircraft's deliveries of about $36 million for the first half of this year were almost four times its total output for all of 1940. As a result, the company earned $4.72 a common share for the six months ended June 30, 1941, compared with $2.30 for the entire year 1940. Current earnings were after preferred dividends and after allowance of $4,260,000 for taxes based upon pending legislation. It is small wonder that Consolidated represented the only stock in the aircraft group to record an all-time new high.

The market place is quick to reflect the ever-changing fortunes of industries and of individual companies. Table 1 illustrates the relative evaluation of the major aircraft companies in recent years. Proper explanations may be found for the fluctuations in every instance.

For example, in recent months Glenn L. Martin Co. has been among the most backward performers. An examination of the company's semi-annual report provides the answer. Any interruption to production has a profound effect upon earnings. Rearrangement of plant facilities in connection with its expansion program together with failure to receive parts and sub-assemblies in time are believed responsible for the curtailment of deliveries at Martin. Shipments in the second quarter dropped to $10,320,144 from $17,063,147 in the first three months. Merely continuing the production rate of the first quarter would not have been sufficient to maintain earnings. Ever-mounting taxes and other expenses must be overcome by increased deliveries. Although the ratio of net income before taxes to total sales in the first half showed little change for all of 1940 at 26.6 percent compared with 27.5 percent, this ratio, after tax provisions, dropped to 10.8 percent in the first half of 1941 from 17.7 percent for the full year 1940. Net profits after taxes for the first half of 1941 were equal to only $2.69 a share compared to $3.92 for the like 1940 period.

As smooth production is attained together with the necessary receipt of engines, propellers and other parts, Martin may be expected to attain its long anticipated mass output of aircraft. That the B-26 for the Army and the 187 or "Baltimore" may soon roll in volume is indicated by a company statement that the "curve of production will rise sharply during the last half of the year".

The industry record for deliveries is probably being established by Curtiss-Wright. Estimates place present monthly production at about $30 million. All three divisions—engine, propeller and plane—are estimated to have had about $60 million in billings for the second quarter of 1941 or almost three and one-half times the deliveries of the like 1940 period. Shipments are reported as steadily rising. A statistical service estimates that the company's 1941 deliveries will exceed $300 million which would compare with $138.7 million in 1940. Final net for 1941 is estimated by this same service at $25 million which after dividends on the "A" stock would leave $3.00 a common share. It is likely, however, that this projection is too sanguine as taxes may make substantial inroads in earnings. In any event, the company has an excellent chance to exceed its reported earnings for 1940 of $1.81 per share.

New delivery peaks are also being recorded by United Aircraft Corp. The company's shipments aggregated about $67 million in the second quarter and compared with nearly $57 million in the first quarter of 1941 and with $22.5 in the corresponding period of 1940. Despite these heavy deliveries, net earnings of 30 cents a share for the second quarter of 1941 were lower than the $4,806,495 or $1.80 per share reported for the first three months. This is largely attributed to the establishment of a reserve for anticipated federal tax increases for the entire first half of the year. United Aircraft is still far removed from peak operations. It is expected that as increased volume of shipments is attained, the company will be able to offset increased taxes as well as the lower unit of profit margin currently prevailing.

Most anyone can make a noise simulating a military expert; no one, however, can accurately foretell the time and final outcome of the war. A choice may be made of "informed" projections which forecast Germany's downfall before the end of 1941 to a period within two years. Certainly we are much closer to a final decision than we have ever been. Every major aircraft builder has backlogs extending beyond two years at least, even assuming increased production schedules. The aircraft industry's total unfilled orders now aggregating more than $6 billion may soon be expanded to a total of $10 billion.

Planes are needed now when they can be put to their most effective use—that is paramount. To the aircraft builders, it is essential that they bite into their backlogs and get final billings under their belts. Production delays may prove particularly costly. Volume shipments, assuming a fair profit margin, mean satisfactory earnings even after all taxes. Failure to show increased deliveries may make impressive backlogs an object of academic interest only. It is logical to assume that termination of hostilities within the next year or two may also bring the diminution of unfilled orders. In this event, it is unlikely that cancellations while carrying proper compensation for losses sustained in the action, will also include a profit margin on unfilled business. Such are some of the major risks in the aircraft industry. Stated simply: The aircraft builders along with other industrial enterprises, are assured of a high level of business activity as long as the war continues.

It is noteworthy that investment trusts have been heavy sellers of aircraft equities during the second quarter of the year. The fact that railroad equipment issues have also been sold is significant as to fears entertained for all investments in armament inspired industries. However, as a group, investment trusts have not always been correct in appraising future trends. Their current action is noted as an indication of the apparent views of an important segment of capital.

(*Turn to page 144*)

The Finest that Money Can Buy

BONNEY TOOLS

Only Bonney Can Give You Wrenches With All The Advantages of ZENEL Steel

ZENEL Steel—an exclusive Bonney development—is the hardest, tough wrench steel on the market.

Because of it's great strength and wear-resisting properties, Bonney Wrenches made of ZENEL are especially adapted to production and service work in the aviation industry. They not only stand up well under exceptionally severe service, but are virtually unbreakable. In fact, they actually outlast two or three wrenches made of ordinary steels.

The peculiar properties found only in ZENEL Steel have made it possible to completely redesign the Bonney Line of Engineers' Wrenches (illustrated) and Tappet Wrenches.

Bonney Wrenches forged of ZENEL Steel are lighter in weight, have narrower, pear-shaped heads, and longer, thinner panelled handles than any other wrenches with similar size openings. Because of these features they are especially adapted to work in close quarters where it would be impossible to use ordinary wrenches.

They are carefully heat-treated to bring out the ultimate strength of the steel and have a lasting, rust-resistant finish.

Bonney ZENEL Engineers' Wrenches are made with 28 different combinations of openings—a different size opening in each end—from 1/4" to 1 1/4". Bonney ZENEL Tappet Wrenches are made with 9 different combinations of openings—a different size in each end—from 7/16" to 1". They may be purchased singly or in complete sets to meet individual needs.

Your local Bonney Jobber carries ZENEL Wrenches in stock. Have him show them to you today and compare with any others you have ever used.

BONNEY FORGE & TOOL WORKS, ALLENTOWN, PA.

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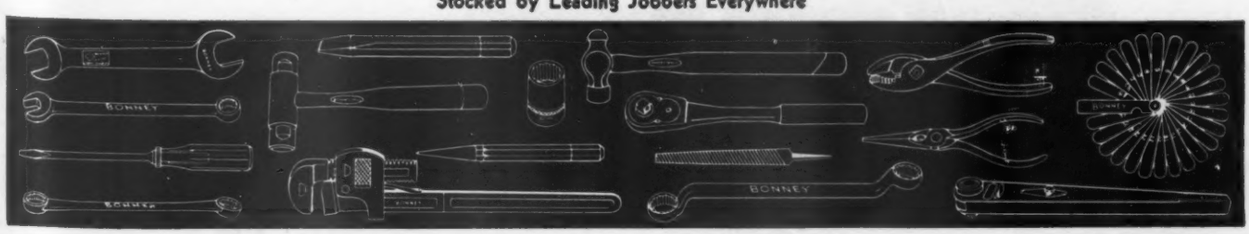
Stocked by Leading Jobbers Everywhere



"BALTIMORE" . . .

★

PROPHECY: "It will prove superior to any aircraft of its type now flying in Europe" . . . "will outperform many of the latest pursuit types in actual combat" . . . "probably the world's fastest bomber of its class." The Royal Air Force expects much of its new Martin "Baltimore" Bombers.

PRODUCT: Built to meet R. A. F. tactical requirements as dictated by modern air warfare, the "Baltimore" is designed for triple duty: as a high-speed medium bomber, for long range reconnaissance, as a heavily armed twin-engine fighter. It carries a crew of four, has an all-plastic nose which broadens the bombardier's range of vision, carries heavy offensive and defensive fire power including a power-driven gun turret.

PRODUCTION: Months between design and delivery already have been saved—for the first "Baltimore" Bomber, which completed its rigid flight tests in June, was no mere prototype. It came straight from the production line—a product of simplified, accurate, high efficiency tooling—with many more following close behind. Look up, Britain! Your new "Baltimore" Bombers are on the way!

★

Martin AIRCRAFT

Builders of Dependable MARTIN USA TRADE MARK *Aircraft Since 1909*

LET'S GO! U.S.A. KEEP 'EM FLYING!

THE GLENN L. MARTIN COMPANY

. . .BRITAIN BOUND!

BALTIMORE, MARYLAND, U. S. A.

BUYER'S LOG BOOK

What's New in Accessories, Materials, Supplies, and Equipment

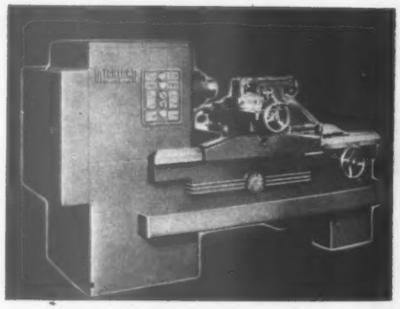
To reduce the temperature in bomber fuselages during completion of work on the planes after they are rolled out on the field, Lockheed Aircraft Corp. is using a large number of evaporative coolers manufactured by the *Utility Fan Corporation,* of Los Angeles, Calif. Each air cooler is connected to the flare chute of the bomber fuselage by means of a canvas sleeve. The fuselage is kept closed except for a small air outlet. The coolers circulate a stream of air that is cooled and filtered by moist pads, kept wet by a self-contained pumping unit.—AVIATION, *September, 1941.*

Utility Fan Evaporative Cooler

To permit installation in conduit wiring systems, type D Mu-Switch, made by *Mu-Switch Corp.,* Canton, Mass., is now available in a cast metal housing $1\frac{1}{2}$x$2\frac{3}{4}$x$3\frac{1}{2}$ in. overall. For industrial and machine tool applications, housing is of bronze with hub tapped for $\frac{1}{2}$ in. pipe thread; for aircraft application, an aluminum case is used with male $\frac{3}{4}$ in.-20 thread, others to specification. A readily removable base, with two mounting holes on $1\frac{1}{2}$ in. centers, gives access to the large, binding screw terminals of this 2 kw. precision switch. An important feature of the conduit style, type D Mu-Switch, is its built-in blow out magnet which quickly quenches the d.c. arc, thus prolonging contact life and obviating need for condensers or other external contact-protecting devices.—AVIATION, *September, 1941.*

Mu-Switch Type D Model

Designed especially to simplify and speed manufacture of rotary cutting tools of various types, and of special value to aircraft engine production, a new universal cutter relieving machine has just been developed by *Michigan Tool Co.,* Detroit, Mich. Machine is suitable for relieving form, gear and rack cutting tools, end milling cutters, spot facers, etc., with radial or side relief or both. Included in design are multiple range of forward and reverse speeds; turntable for cam slide, permitting relief from any angle; universal adjustable tool box for quick set up; quick-interchangeable cams, and lubrication from reservoirs with inspection portholes. Machine will handle work up to 8 in. in diameter, with maximum length between centers of 24 in. Number of teeth that can be relieved ranges from 1 to 24, and maximum relieving stroke is $\frac{3}{4}$ in.—AVIATION, *September, 1941.*



Mich. Tool Cutter Relieving Machine

A timely answer to the problem of licking corrosion without zinc coated metal is given by *Roxalin Flexible Lacquer Co.,* Elizabeth, N. J., in their statement that "Roxaprene", a corrosion resistant speed synthetic, provides superior performance to galvanized metal at a fraction of the processing cost. When immersed in 2 percent caustic solution, Roxaprene is unaffected at the end of 600 hrs., whereas unpainted hot dip galvanized steel shows corrosion in 50 hrs. And in the same dilute hydrochloric acid solution which ate through galvanized coatings in $2\frac{1}{2}$ hrs., Roxaprene showed signs of failure only after 96 hrs. Requiring no special treatment, Roxaprene applies like paint finishes in general use and may be forced dried in 50 percent of the time required by ordinary synthetics.—AVIATION, *September, 1941.*

A new spring, which utilizes the property of a 36 percent nickel steel to become stiffer as its temperature increases, is now made available commercially by *All-Weather Springs,* 72 Washington St., New York, N. Y. Such springs are combined with undercorrecting springs; i.e., springs having an opposite tendency, or with other elastic elements such as a bellows, diaphragms, etc., to produce instruments, the accuracy of which is virtually unaffected by temperature changes.—AVIATION, *September, 1941.*

A 230 volt industrial Multi-breaker, at little more than the cost of a type A switch, is announced by *Cutler-Hammer, Inc.* The new breaker is said to afford exceptionally economical application as a motor circuit switch or service disconnect switch. It is fuseless, with a bimetallic strip actuation, visible trip indication, and trip free lever. Completely enclosed and semi-dust-tight, it is quick make and quick break, with a rated capacity of 230 v. from 15 to 100 amp., available in 3 pole, 3 pole solid neutral or 4 pole solid neutral types. Calibration is set at factory and cannot be tampered with.—AVIATION, *September, 1941.*

Cutler-Hammer Multi-Breaker

BALL BEARING DO'S AND DON'TS FOR MECHANICS

Gus sure hit the ceiling the day he caught Elmer Esswrench – that's our new mechanic – dunking a brand new ball bearing in a bucket of dirty gasoline. "So ya think yer cleaning it, huh?" yells Gus. "Why not clean yer new watch along with it?"

GUS SAYS "DON'T!"

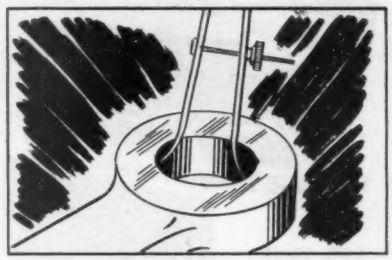
DON'T issue any bearings to mechanics until they're actually ready for them.

DON'T strike bearing shield while mounting, and don't let it foul on an adjacent part. A bent shield may lock it tight.

DON'T attempt to clean or grease new ball bearings; the maker's already done this job.

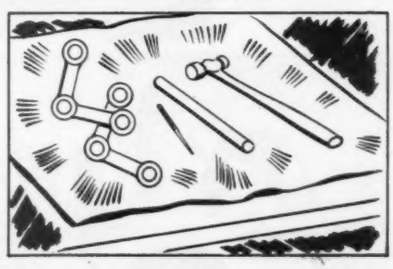
Preparing for Mounting

Second of a series of instruction sheets published by the Aircraft Division, The Fafnir Bearing Company, based on ten years' experience with the leaders of U. S. aviation.



CHECK HOUSING for size, squareness, roundness, and cleanliness. Bearing should fit snug, but not too tight or it won't run freely.

CHECK BOLT or shaft for size, roundness and cleanliness. A bearing riding in an out-of-round housing, or on an out-of-round shaft, will soon be loose.



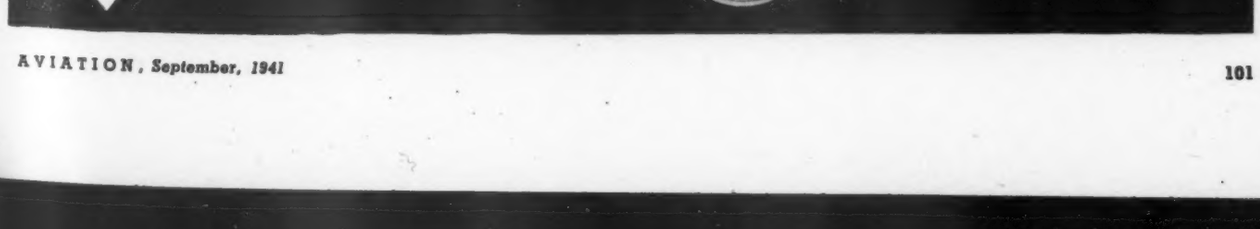
BEFORE OPENING bearing boxes, spread a clean newspaper on the bench, and clean your hands and tools. Take a lesson from a watchmaker, and remember the bearing you're about to handle is made to even closer tolerances than a watch!

OPEN BEARING boxes and unwrap bearings as you need them. Don't leave unwrapped bearings exposed on the bench. There's enough dust in the air to cause trouble for bearings having no seals.

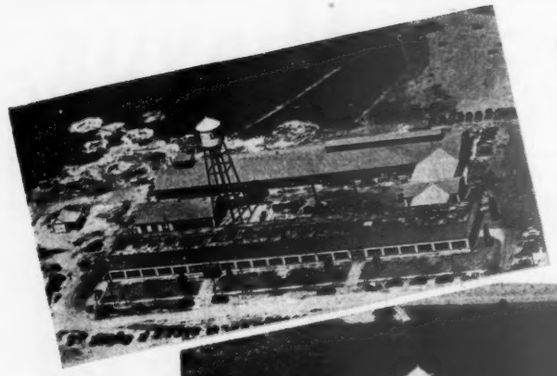
DON'T WASH or wipe new bearings. They're already cleaner than you can get them.

DON'T TRY to lubricate new double sealed bearings. Fafnir pre-packs them at the plant with a special grease, measured to the fraction of a gram.

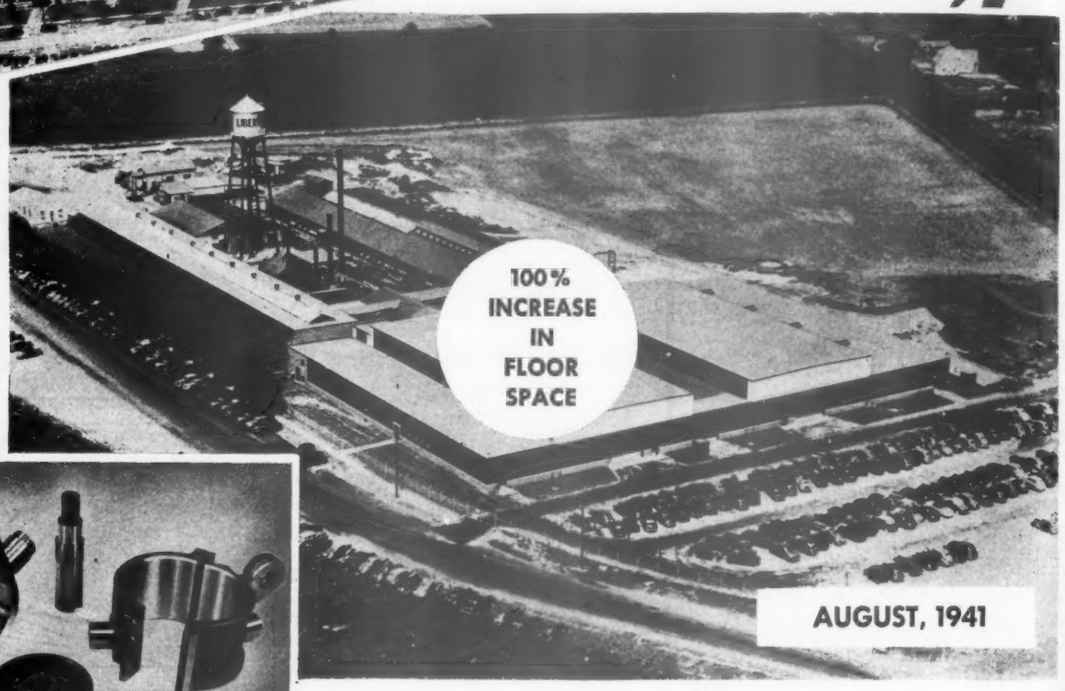
BEARING PROBLEM? Don't sprain your brain on it. Write Fafnir and our Aircraft Engineers will sprain theirs – but you'll get the answer. The Fafnir Bearing Company, Aircraft Division, New Britain, Conn.

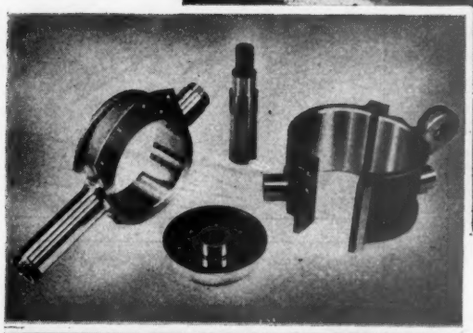


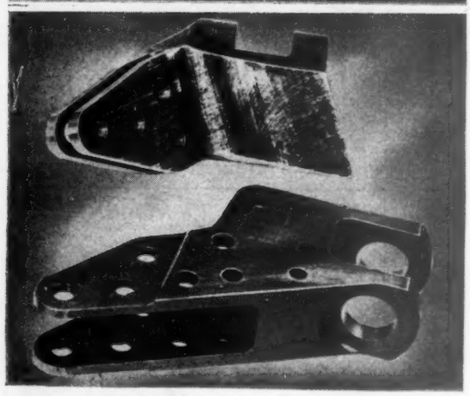
THE GROWTH OF *Liberty*



FEB 1941







PRECISION machine parts — tools — production machine parts to order — screw machine products — milling and gear cutting work — engine cylinders, pistons, crankcases — heat treating and carburizing in electric furnaces with atmospheric control — cadmium plating and anodizing aluminum alloy parts — aircraft sheet metal work — wing assemblies — tail surfaces — pontoons — bomb racks — complete aircraft doping and finishing work.

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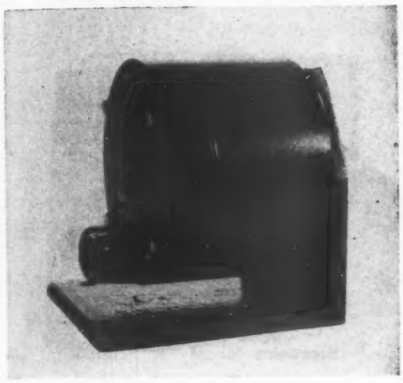
New Kollsman Direction Indicator

New angle type model of Kollsman Direction Indicator, with the dial on a 45 deg. angle, intended for mounting at lower part of the instrument panel, has recently been developed for the Navy by *Kollsman Division of Square D Co.,* Elmhurst, N. Y. Angle type model has all the features of the Kollsman Direction Indicator with the vertical dial. These include the stationary compass-rose dial with movable pointer and the reference index settable to any desired heading, making it necessary only to match pointers.—AVIATION, *September, 1941.*

For use in measuring r.p.m., feet per hour, gallons per minute in any manufacturing plant where rotating equipment is used, a new a.c. tachometer is announced by *Westinghouse Electric & Mfg. Co.,* East Pittsburgh, Pa. Known as Type A-80, the tachometer consists of an a.c. generator and a voltmeter of the rectifier type. No brushes or commutator are used in the generator which is of the permanent magnet, a.c. inductor type. Magnets are made of high grade magnet steel and are carefully aged. Rotating element consists of laminated iron keyed to rust resisting steel shaft. Laminations are slotted to permit variation of the air gap reluctance when shaft is rotated. Although best generator speed is 1000 r.p.m., the tachometer is recommended for operation over a range of from zero to 5000 r.p.m.—AVIATION, *September, 1941.*

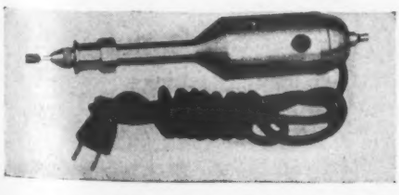


Westinghouse Tachometer

Designed to keep the pilot comfortable through a temperature range of 130 deg., from 70 above zero to 60 below, a newly perfected, electrically heated flying suit has been developed by *General Electric Co.,* Bridgeport, Conn. Said to be many pounds lighter than the sheepskin lined garments they replace, the new suits will also give pilots far more facility in manipulating controls and armaments. Working for months with Army technicians, the final design developed by General Electric consists of an outer shell of all wool cut on the bias for elasticity. The wires were sewed on the inside of this outer shell, and the lining made of 100 percent cotton cloth which permits radiation of heat to the body. The electrified boot is worn inside standard light aviation boots.—AVIATION, *September, 1941.*

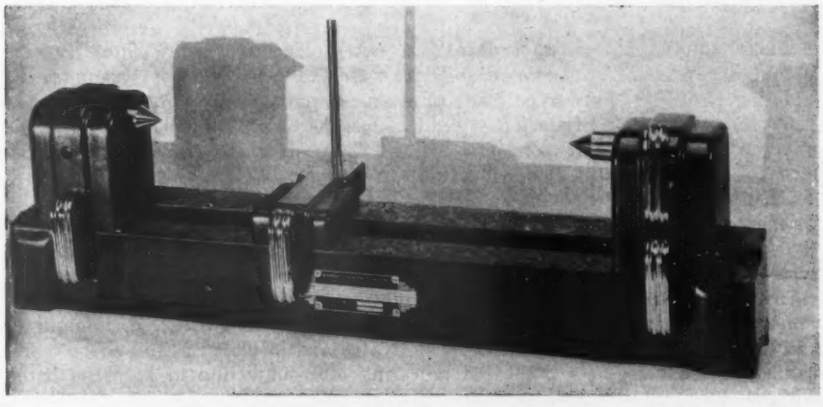
General Electric Heated Flying Suit

For high speed precision and production work, a new Super Deluxe tool for grinding, polishing, drilling, routing, carving, etc., is made by *Small Motors, Inc.,* Chicago, Ill. It may be used on all types of products requiring high speed (30,000 r.p.m.) accurate precision work. Tool is said to be well balanced in the hand and easily manipulated in doing the most difficult job. Spindle has two high grade ball bearings with a rear self-aligning bronze bearing. Operating on 110 volts a.c.-d.c., tool is furnished complete with 8 in. cord and plug, two wrenches, two collets, ready to operate.—AVIATION, *September, 1941.*

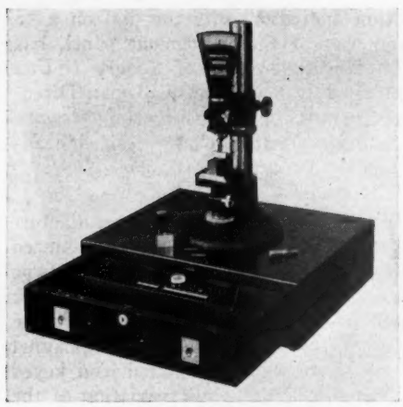


Small Motors Super Deluxe Tool

The new improved Bench Center for inspecting a wide variety of small work up to 6½ in. diameter by 18 in. long, is announced by *Barber-Colman Co.,* Rockford, Ill. Providing a very accurate, fast method for inspecting cylindrical and circular pieces, it has a quick-acting lever on the tail center which, when moved to the left, clamps the center, and, when moved to the right, unclamps and retracts center all in one motion. Heavy work, it is said, cannot force center back and destroy accuracy. Design of ways and clamps insures free and quick sliding centers and indicator base when unclamped. Quick-acting, powerful clamps hold indicator base and centers rigidly in position, and a large sturdy center provides greater wearing surfaces in holes to preserve original accuracy throughout a long life.—AVIATION, *September, 1941.*



New Barber-Colman Bench Center



Scherr Comparitol-Inspectoset

Heath Swivel Tailwheel Assembly

For the particular benefit of sub-contractors, the new Scherr Comparitol-Inspectoset Unit, made by *George Scherr Co.*, New York, N. Y., should be of great value in eliminating many rejections completely. Included in the new unit is the Comparitol, which is graduated to read 1/10,000 in. plus and minus .002 in., and the Ultra-Chex Inspectoset consisting of 34 gage blocks which will make up all combinations in steps of 1/10,000 in. from .300 in. to 8 in. The Comparitol is first set with the Ultra-Chex in the Inspectoset, after which parts can be checked quickly and easily by unskilled help.—AVIATION, *September, 1941.*

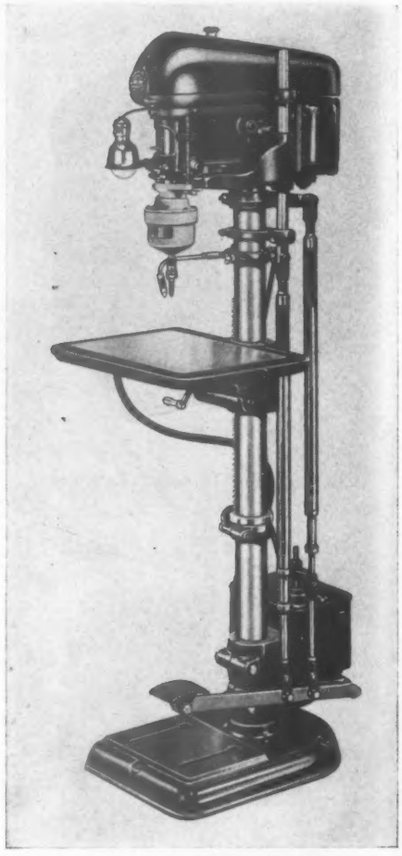
New single arm, ball bearing swivel tailwheel assembly, made by *Heath Co.*, Benton Harbor, Mich., is a fine addition to their deluxe line of lifetime guaranteed tailwheels for lightplanes. Features of the tailwheel are the ball bearing swivel which requires lubricating only four times a year, thus eliminating constant attention. Ball bearings give feather weight action on the rudder when used as steerable, and when used as full swivel give instant action in ground maneuvering. The single arm feature eliminates hazard of mud clogging and also minimizes danger of clogging with slush and freezing in winter. Toughest nickel steel is used in castings and assembly is guaranteed against breakage.—AVIATION, *September, 1941.*

A tapping machine which handles a wide range of materials and sizes, with four operating speeds from 390 to 2050 r.p.m., Procunier Model "AA" Universal, has been brought out by *Procunier Safety Chuck Co.*, 12 S. Clinton St., Chicago, Ill. Two interchangeable Procunier tapping heads provide a capacity range from No. 2 tap to ½ in. inclusive. A unique arrangement of long helical springs, adjustable over a wide range, is said to maintain pre-set tapping and reversing pressures independent of operator, facilitating precision tapping at high speeds with maximum protection for taps and work.—AVIATION, *September, 1941.*

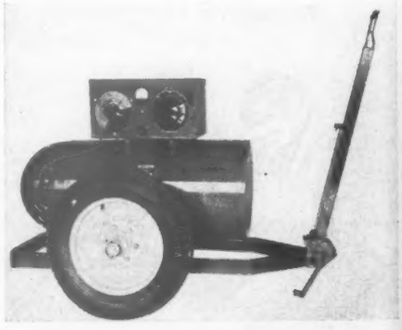
For easy, fast portability in shop or yard, *Lincoln Electric Co.*, Cleveland, Ohio, have a new two-wheeled light weight pneumatic-tired trailer for mounting arc welding machines. Designed for either Lincoln SAE 200 to 600 amp. a.c. motor driven, or Type SA 200 special engine driven Lincoln arc welders, mounting is readily accomplished by means of four bolts in frame of trailer which register with holes in lugs on the welding machine. Unit can be used for road towing up to 30 m.p.h., measures 66x42x16 in., weighs 282 lb.—AVIATION, *September, 1941.*

To help you meet "contract dates", a new solderless "Screw-Tite" Lug is announced by the *Ideal Commutator Dresser Co.*, 5146 Park Ave., Sycamore, Ill. This lug is the set screw type made of seamless, pure electrolytic copper with a heavy brass check-proof shell that reduces heating. Full current carrying capacity is evenly distributed from wire to lug. Eight sizes are available for No. 14 wire to 2,000,000 C.M. Cable.—AVIATION, *September, 1941.*

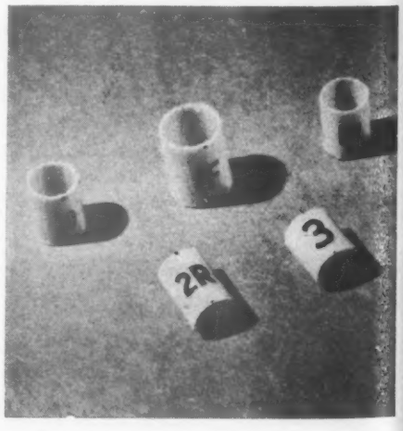
To meet increased demands under the National Defense Program, *William Brand & Co.*, New York, N. Y., have developed an ignition marker from their standard type of TURBO Varnished Tubing. Markings are indelibly impressed on the varnished surface, and are designed and fabricated to meet Army-Navy specifications. Salt water resistance at temperatures from 68 to 78 deg. F. is assured, and the white braided cotton tubing is so treated and insulated as to resist 24 hrs. baking at 258.8 deg. F. Repeated reheating and subjection to kerosene baths without resultant cracking of yarn or varnished surface is also assured.—AVIATION, *September, 1941.*



Procunier Model "A" Tapper



Lincoln Elec. Arc Welding Trailer



Brand Ignition Markers

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Military and Civil Aircraft ...rely on ELECTRONIC VIBRATORS

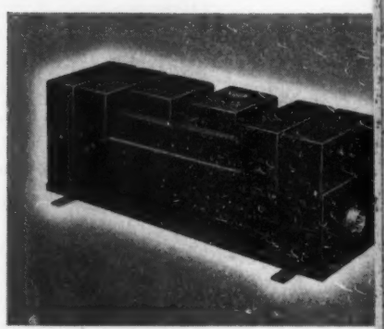
Electronic Vibrator . . . heart of Electronic Converters . . . as used in Sperry Directional Compass.

Military and civil aircraft require power sources of unfailing dependability under *all operating conditions.* That's why Electronic Vibrator Power Supplies are so widely used on U. S. Army, Navy and Coast Guard planes . . . as well as commercial airliners and privately owned aircraft.

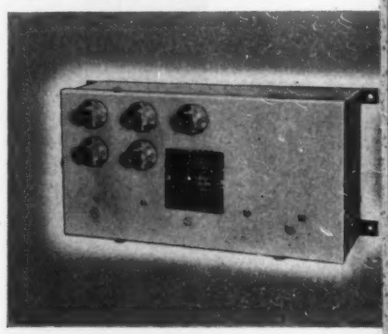
The exceptional preference for Electronic Vibrators is the direct result of many vitally important features found only in this product: . . . light but rugged construction . . . constant frequencies . . . synchronous operation . . . range of 0 to 500 watts at any voltage . . . long trouble-free performance! . . . That's why there are more Electronic Vibrator Power Supplies flying *than all other makes combined.*

In addition to Vibrator-Type Power Supplies, Inverters and Control Boxes, Electronic Laboratories supply the aviation industry with Ultra-Violet "Black Light," a significant advance in aircraft instrument illumination . . . fluorescent cabin lighting . . . custom-built lamp assemblies and fixtures . . . a combination of services seldom found in one organization.

Electronic products are *trusted flight companions* of both military and civil airmen. For further technical information, address the Aircraft Division of Electronic Laboratories.



Electronic Autosyn Inverter Type S-525 . . . power source for instruments of the great Boeing Flying Fortress.



Electronic Type S-665 . . . converts 12 or 24 Volt DC to 110 AC for operation of fluorescent lamps.

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SILVAIRE 8D-1 SPECIAL TRAINER

Cruising speed 110 m.p.h.
Landing speed 42 m.p.h.
Cruising range 550 miles
Gross Weight 1310 pounds
Useful load . 600 pounds
Fuel Capacity . 23 gallons
Wing Loading
9.3 lbs. per sq. ft.

Standard Equipment: Dual ignition, 75 h.p., fuel injector, positive mechanical brakes, steerable tailwheel, compensated compass, primer, wing tanks, extra large baggage space, airliner type trim tab, formed "Vinylite" windshield, fully upholstered cabin, crackled finish instrument panel with provision for full radio and blind flying instrument equipment, parachute type seats with deep removable cushions, carpet, map pocket and ventilation window.

You'll see the new Silvaire 75 h.p. 2S Trainer at airports where the big CPTP operators are hard at work teaching all they know to America's primary defense pilots. Built especially for the cross country and night phases of the new Secondary Course, this fast long-range airplane flies more like a military ship than any of the so-called "lightplanes."

Powered by the economical 75 h.p. Continental injector engine, the Silvaire 8D-1 gets off like a jack rabbit, cruises 550 miles at 110 miles per hour and lands at only 42. Economical to operate, this ship in the "highest-resale-value" class fully equipped for primary training is inexpensive to buy. Ask your dealer today for a convincing demonstration and financing details.

Silvaire airplanes powered by 65 h.p. Continental and Lycoming and 75 h.p. Continental engines are available to CPTP operators and CAA approved schools. Be sure to see the Silvaire de-Luxe and Silvaire Master available with full equipment including starter and mufflers for immediate delivery.

For FREE descriptive literature and prices, write to Dept. N

Interior of 8D-1 shown at right

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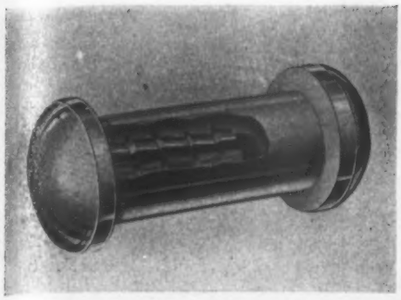
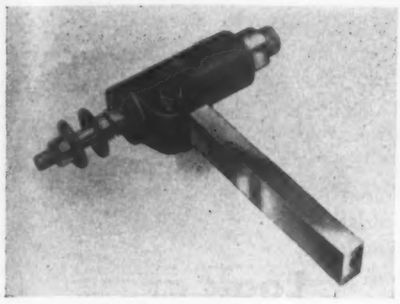
WEST TRENTON, NEW JERSEY

LUSCOMBE AIRPLANE CORPORATION



Corbin Fastener

An ideal fastener for confined spaces where heating, hammering or upsetting is impractical, and which will increase product strength by controlled pressure, is made by *Corbin Screw Corp.*, New Britain, Conn. A slotted, tapered stud having annular grooves, locks within an internally serrated sleeve (not threaded). By simply pressing the two parts together, the tapered sides slide over each other allowing the vertical sides to engage and lock. Where external expansion is required, principle can be reversed, using a solid serrated stud and a split internally serrated sleeve. No special tools are required. A light hammer blow or compression with pliers is sufficient to form a solid permanent connection. Because pressure is certain, it permits use with brittle plastics or rubber without risk of breakage or distortion.—AVIATION, *September, 1941.*



Stow Tool Post Attachment

Your lathes may now be adapted to many different grinding operations, both external and internal, by a new tool post attachment produced by *Stow Mfg. Co.*, Binghamton, N. Y. The device accommodates grinding wheels as large as 6 in. diameter by one inch face. By taking off the clamp spindle and substituting the Stow Collet Chuck a variety of mounted wheels and points may be operated for internal grinding and recess surfacing. On the tool end the Tool Post attachment is fitted with a combination radial thrust and annular ball bearing, and on the shaft end, a floating, self-aligning ball bearing is used. This rigid spindle support insures true running of unit at speeds as high as 6800 r.p.m.—AVIATION, *September, 1941.*

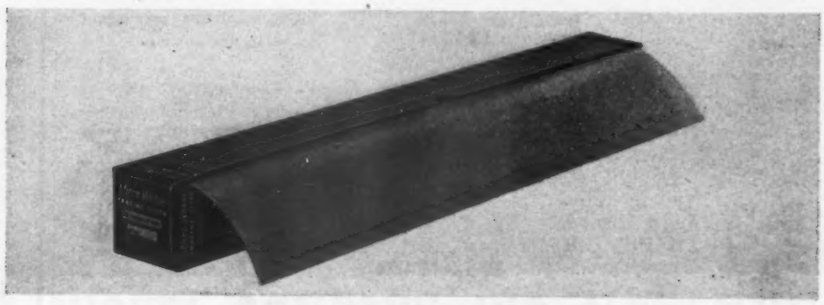
Dayton Rogers Die Cushion

Improved heavy duty die cushioning equipment, self-contained and carrying their own surge tanks, is now being made by *Dayton Rogers Mfg. Co.*, Minneapolis, Minn. Designated Model 2C Pneumatic Die Cushion, these cushions can be furnished in multiples of two, four or six, having maximum ring holding pressure up to and including 90-ton, with drawing capacity for deep drawing shells up to and including 10 in. Each cushion installation is supplied with a combination regulating reducing valve and pressure gage to retain correct draw ring holding pressure and pressure pad control throughout the work cycle, on a given job. Working pressure is recorded at all times, p.s.i., on the pressure gage furnished with each installation.—AVIATION, *September, 1941.*

For increasing the range of operation of pursuit ships to include new muddy or sandy landing fields, or other terrain in which a plane would bog down, *Firestone Tire & Rubber Co.*, Akron, Ohio, have a new flat profile airplane tire to aid the air arm of national defense. New tire has a flat, wide tread that extends nearly to the sidewalls, reinforced with rubber ribs or buttresses. Whole tread thus comes in contact with the soil without having to sink in to get contact area, and in addition to increased flotation thus given, the design adds stability and prevents sideslipping when landing. In tests, it was found the tire actually packed the soil under the tire, offering far less drag to the plane as it moved swiftly over soggy terrain with this type of airplane tire, quicker take-offs should be possible from muddy fields, a definite advantage in time of a sudden bomber onslaught from the enemy, and the greater safety will increase the efficiency of fighter craft.—AVIATION, *September, 1941.*

Firestone Flat Profile Tire

Micro-Weave Tracing Cloth, in three different types, is produced by *Holliston Mills,* Norwood, Mass. The tracing cloth is made in ink cloth; white pencil cloth, dull on one or both sides, and blue pencil cloth, dull on one or both sides. It is put up in special corrugated box containers that act as dispenser boxes, keeping cloth clean at all times. Hooks are supplied on request, so that the box may be clamped to sides of desk, wall or table.—AVIATION, *September, 1941.*



Holliston Micro-Weave Tracing Cloth

These airports have *paved for the future* WITH CONCRETE

AIRPORT AND CONCRETE YARDAGE	WHEN CONSTRUCTED	COMMENTS
Floyd Bennett Field—311,200 sq. yds.	1929-30 (2 runways and aprons) 1935-36-40 (additions)	Heavy traffic. Excellent condition. Maintenance cost negligible.
Rhode Island State Airport—220,000sq.yds.	1935-41	Very small expense for maintenance. Excellent condition. Includes 41,800 sq. yds. under contract.
Grand Central Air Terminal, Glendale, Cal.—39,000 sq. yds.	1928-29	Excellent condition. Little maintenance needed.
Lunken Field, Cincinnati Municipal Airport—140,000 sq. yds.	1932	After 9 years of traffic and a flood 20 ft. deep, pavement in excellent condition.
Wayne County Airport, Detroit—242,000 sq. yds.	1929-30—1940-41	Performance of 193,000 sq. yds. built in 1929-30 led to use of concrete for 49,000 sq. yds. extension in 1940-41.
Indianapolis Municipal Airport—145,000 sq. yds.	1930-36-37-40	Original concrete runways and aprons progressively extended—with the same type of pavement. More concrete planned.
Wold-Chamberlain Field, Mun. Airport of Minneapolis—415,000 sq. yds.	1935-36-40-41	174,000 sq. yds. in 1936. 241,000 built or under construction, 1939 to date. Additional 278,000 planned.
Toledo Municipal Airport—164,000 sq. yds.	1940-41	Rebuilt with concrete to replace a short-lived surface which originally cost about as much as concrete.
Hamilton Field, San Rafael, Cal.—338,000 sq. yds.	1934 (aprons) 1939 (runways)	Excellent performance of aprons built in 1934 dictated choice of concrete for new runways.
Barksdale Field, Shreveport, La.—292,000 sq. yds.	1932-1940	175,000 sq. yds. placed in 1932 has given good service—117,000 sq. yds. more in 1940.

Look at Concrete's Record at Typical Airports

Which type of pavement for airports has the best record for standing up under ever-increasing traffic?

Which has served the longest periods with lowest maintenance and least annual cost?

Which has provided greatest safety in all weather, greatest strength in emergencies?

Service records of leading airports say: CONCRETE! Records like these explain why 50 fields now have concrete runways; why concrete is the choice for over 15,000,000 sq. yds. of airport pavement, including that now being rushed to completion at civil and military airports.

Insure years of safe, economical, all-weather operations by specifying concrete for runways, aprons, turn-arounds and taxiways of main airports. Design and construction data on request.

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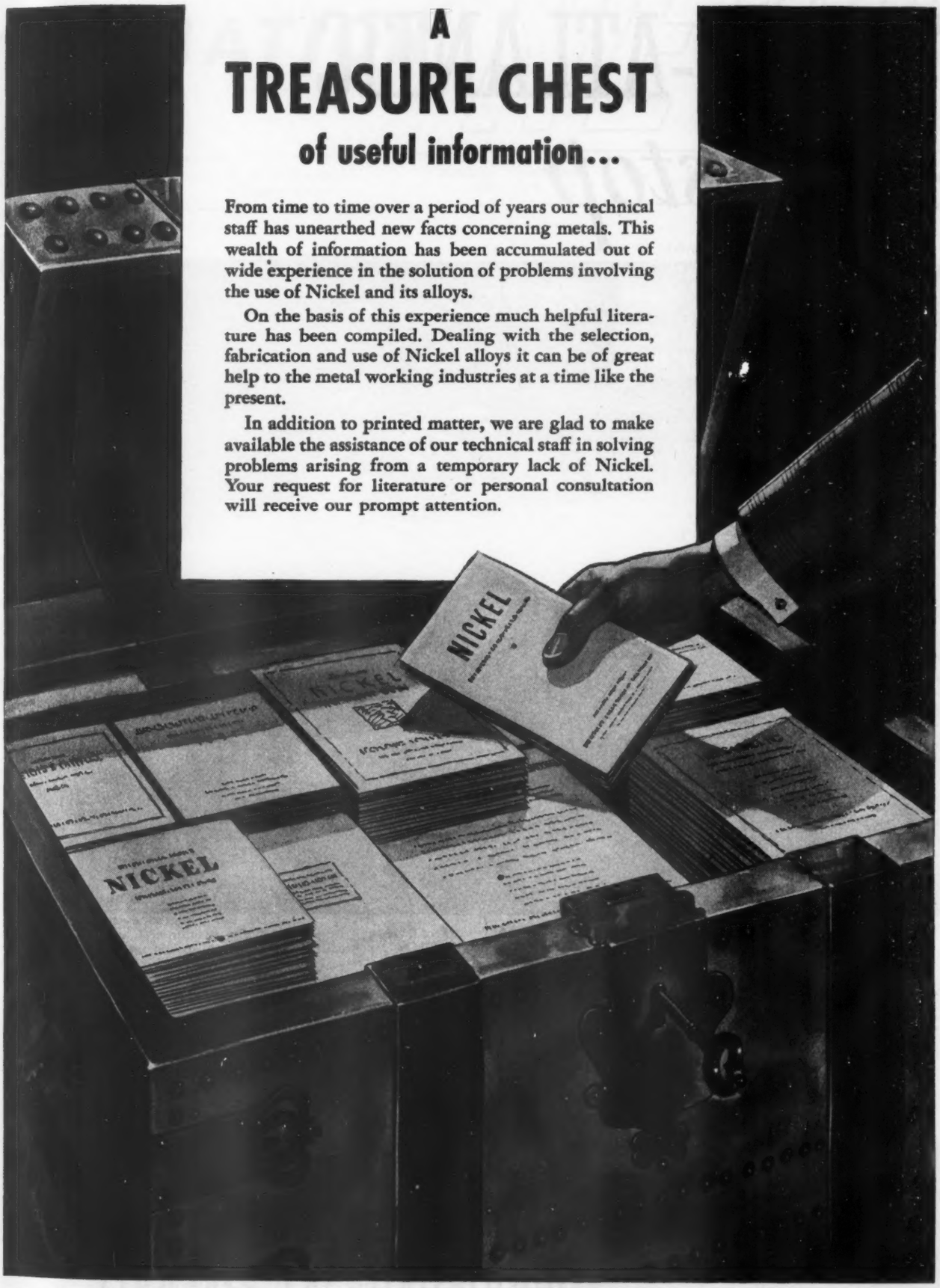

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From time to time over a period of years our technical staff has unearthed new facts concerning metals. This wealth of information has been accumulated out of wide experience in the solution of problems involving the use of Nickel and its alloys.

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In addition to printed matter, we are glad to make available the assistance of our technical staff in solving problems arising from a temporary lack of Nickel. Your request for literature or personal consultation will receive our prompt attention.

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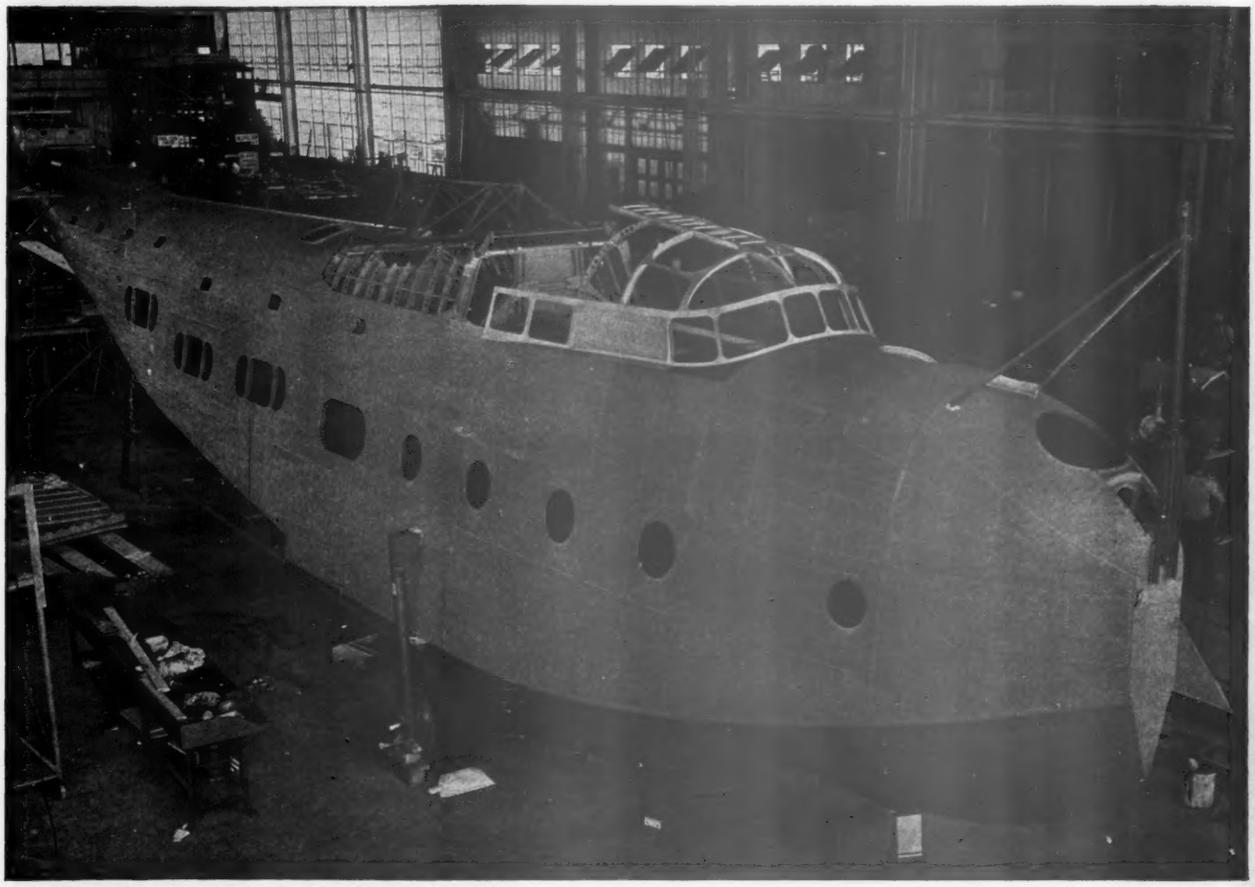
Non-stop



One of the hulls shortly after removal from the jigs

THREE SIKORSKY VS-44A's are rapidly nearing completion for delivery to American Export Airlines.

These huge flying boats are specifically designed for non-stop trans-Atlantic operation, carrying full load of passengers, mail, and cargo . . . worthy successors of the earlier Sikorskys that pioneered both the Atlantic and Pacific air routes.

VOUGHT-SIKORSKY AIRCRAFT

STRATFORD, CONNECTICUT

ONE OF THE THREE DIVISIONS OF UNITED AIRCRAFT CORPORATION

THE AVIATION NEWS

BLAINE STUBBLEFIELD, Washington | C. F. McReynolds, Pacific Coast | Randolph Hawthorne, New York | E. R. Lockin, New York

SEPTEMBER 1941

Five Air Support Commands Are Organized

4 for Field Armies; 1 for Armored Force

Five Air Support Commands have been set up within the framework of the Air Forces Combat Command to promote effectiveness of the Army air-ground team. This move follows close upon reorganization of the air arm to give it "autonomy" within the Army. Military observers here believe this indicates any intention of complying with pressure for an independent air force has been abandoned.

The support commands will include observation aviation (both lighter and heavier-than-air); light bombers, dive bombers, aerial photography, gliders, and air transports for parachute troops and air-landing troops. This is a unified grouping of all the aviation elements that a ground force needs.

The designations of the new commands and their commanders follow: 1st Air Support Command, Col. William E. Kepner; 2nd, Brig. Gen. John B. Brooks; 3rd, Col. Asa N. Duncan; 4th, Col. Robert C. Candee; 5th, Brig. Gen. Junius W. Jones.

Within the Army Air Forces, the first four Air Support Commands are under the control of the 1st, 2nd, 3rd, and 4th Air Forces, respectively, of the Air Forces Combat Command. The 5th Air Support Command will be under control of the Air Force Combat Command.

The First, Second, Third and Fourth Air Support Commands will operate with the First, Second, Third and Fourth Field Armies, respectively. The Fifth will operate with the Armored Force. Thus each of the Army's major strategical and maneuvering units will have an air support organization that is specifically identified with it.

Air Support Commands are intended to augment the combat efficiency of the whole military establishment. The ground forces and their air support units will cooperate in their training and operations plans, assuring unity and coordination, which is essential to success in battle.

The field armies and the Armored Force will not necessarily have to rely only on their particular Air Support Command. If required, additional aviation will be used.

(*Turn to page* 114)

Press Association

TEST PILOT Woodward Burke warms up the engine of the new Brewster dive bomber, the SB2A-1, to put it through its paces for William S. Knudsen and Rear Admiral J. H. Towers, Chief of Navy's Bureau of Aeronautics. (Story on page 117)

Above: Curtiss-Wright's new Plant No. 2 in Buffalo, which was dedicated on August 14th. This plant gives the firm an additional 1,500,000 sq. ft. and will employ some 12,000 men. This is first of three new CW plants to be dedicated. When Columbus and St. Louis are in full production, the airplane divisions of the company will have 5,000,000 sq. ft. of space and 45,000 men. Below: Interior view of the plant with P-40's already being assembled. About 250 planes are being assembled in this scene.

International

Once more national defense production is delayed by a strike. Employees at Curtiss-Wright's Caldwell propeller plant walk out as unions quarrel among themselves as to who represents workers. Few days later all were back to work.

39% of Cadets Joining Navy; 32% Joining Army Are CPT Men; Pilot Increase: 100% in Year

Washington (AVIATION Bureau)—The Army and Navy are "relying to an increasing degree" on the Civil Aeronautics Administration's pilot training courses for flying cadet recruits, says Brig-Gen. Donald H. Connolly, Administrator of the CAA. Analyses for June reveal that 39 percent of all cadets joining the Naval Air Reserve and 31.6 percent of those entering the Army Air Force are CAA trainees.

Connolly said military records show the ratio of CAA boys among Naval aviation enlistments was 44 percent greater in June than during the preceding three months, and among Air Corps enlistments the ratio was 37 percent greater. He attributed the larger Navy increase to the fact that the Navy gives CAA advanced students credit for 43 hours of flying, whereas the Army does not.

"We have every reason to expect that the showing will be even better when statistics are available on the Army's July entering class, which should include many CAA trainees who had not completed their college term by June 6, when the previous Army class began," Connolly said.

A total of 7,400 CAA trainees had volunteered and had been accepted for Army and Navy aviation by June 1, and, in addition, 1,279 CAA instructors had joined defense units here or in Canada.

The CAA is continuing its work as a feeder to the armed air services by giving preliminary flight training this summer to approximately 11,000 candidates; 3,000 are taking the secondary course, and 2,000 are being trained as instructors.

In one year the number of certificated civil airplane pilots has increased by 100.6 percent and licensed planes have increased 58.7 percent, Civil Aeronautics figures show.

There were 41,006 pilots on July 1, 1940. Today there are 82,277. This is mostly due to the pilot-training program of the CAA, which is continuing its "mass production of pilots" with a class of 12,000 now in the summer session of its 1942 program. During the year, this program will produce about 37,000 more civilian pilots in the U.S.

Women pilots total 2,733 of whom 171 are commercial and 2,562 private.

There is a new high in certificated planes, exclusive of military planes, of all types, with a total of 22,025 now listed as against 13,878 a year ago. As in recent years, California has the greatest number of planes, 2,174; Pennsylvania has 2,163, New York 1,610 and Texas 1,237.

50 Aircraft Inspectors Clear Repaired Planes

The first 50 CAA "aircraft inspection representatives" have been apointed to facilitate clearance of civil airplanes for flight after they have been repaired. "Inspection representatives" parallel somewhat the same role that flight examiners have served in the testing of pilots—they will provide more points throughout the country at which airplanes which have undergone repairs can get a prompt inspection for use.

In appointing "inspection representatives", the regular CAA inspectors select technicians of known ability who are presently engaged in fulltime servicing of aircraft. CAA inspectors reserve the right to double-check the inspection representatives' verdicts whenever they desire. The whole idea is to speed up clearances.

With the aircraft inspection representatives helping to handle the burden of routine work, the role of regular CAA inspectors becomes more supervisory in character. The step is in line with numerous moves made in the last three years by which the CAA has sought to decentralize regulatory work, and to delegate more responsibility to the industry under proper safeguards. Contracting with colleges to give ground training and with commercial aviation firms for flight training is part of this policy.

The Ferry Command Lists Women Pilots

The "Ninety-Nines", international group of women pilots, is again affiliated with NAA. Jacqueline Cochran, of New York, recently was elected president at a meeting in Albuquerque. Miss Cochran was the first woman to co-pilot a bomber to England. This achievement caused somewhat of a flurry among the women pilots, some of whom began to ask that the War Department make more use of their talents. Apparently as a result, Col. Olds, chief of the Air Force Ferry Command, has sent out a questionnaire to women holding commercial ratings, asking for a record of their hours, name of instructors, other experience in radio, navigation, engines, ground school work, etc.

Lockheed Lodestars are being sent to Dutch East Indies for troop transports and for work with parachute troops. These two are at Burbank prior to trans-Pacific shipment.

Horsepower Basis For Pilot Rating

Abandoning the weight classification for rating the competency of pilots, the Civil Aeronautics Board has ruled that horsepower shall be the basis of pilot rating after August 1. The same general types of aircraft are retained; airplane, autogiro, glider and lighter than air, with the airplane classification divided into single-engine, land; single-engine, sea; multi-engine, land; multi-engine, sea, and unconventional. Because of the wide range of power plants under 80 hp. the Board has grouped them all into one classification. Thus a pilot, qualified on any plane within that power range, is licensed to fly all planes having up to 80 hp. engines. The rating in planes of greater power qualifies the pilot in a range fifty percent greater and fifty percent less than the plane in which he demonstrates his competence. thus if he qualifies in a plane of 200 hp. he is also given approval for planes having 100 and 300 hp. engines. Minor changes in the rules have been made in the matter of endorsement of certificates, and the Board has issued a detailed explanation of all aspects of the new rule in certificate and inspection division release Number Fifty-four.

Funds for Control Towers And for Alaskan Defense

President Roosevelt has asked Congress for a supplemental Appropriation of $17,686,000 for the Civil Aeronautics Administration to meet the problem of military flying on civil airways and airports. Part of the money is to be used for operation and maintenance of control towers on civil fields used by the Army; part for extensions of fields and expansion of the airway communications system in Alaska. Robert Hinckley, CAA Administrator, recently made a circuit trip in Alaska, in conference with military authorities, on plans for immediate strengthening of defense there, through improvement of civil facilities.

Mrs. Raymond Lee Kidd Exonerated

After hearings before the Civil Aeronautics Board, and investigation by the Administrator, Edna Gardner Kidd, a 5,000-hour pilot and holder of many trophies, has been exonerated and her license has been restored. Mrs. Kidd appeared personally before the Board and was represented by Carl Marshall, attorney, of Gulfport, Miss.

Mrs. Kidd was charged with violating several of the civil air regulations and her license had been suspended. The Board, however, found that the charges were not sustained by the evidence. Mrs. Kidd is the operator of the Southern Aviation School at New Orleans, contractor in the Civilan Pilot Training Program.

Airport Program is $137,000,000; 364 projects Call Bids in 30-60 Days; 60% is For Material

With national defenders calling the dance, the largest airport program in the Nation's history was put into action by the Civil Aeronautics Administration early in August.

The present program concerns 288 projects, and total expenditure of $80,810,110. Which means that upon completion of this program, there will be 127 more airports in the country than when the CAA started its first program last October. Of the original list of 200 airports, 50 have been completed, and the remaining 150 will be completed under the present program. Of the total of 364 projects, the greater number will consist of improvements to existing fields, but the larger amount of money will be spent on building airports where none existed before.

There is a total of about $137,000,000 appropriated for airports, including an estimated $42,000,000 in WPA labor contributations. Actual cash appropriated totalled about $95,000,000 so there is still some $14,000,000 un-allocated.

Locations for new fields and selection of those on which improvements will be made, were determined by a board consisting of the Secretaries of War, Navy and Commerce. This Board, while examining every project from the viewpoint of its value in National Defense, considered it also as a possible future civil airport.

Larger portion of the projects is located in the coastal regions, such as Florida, Texas, California and New England, and in other sections where extensive Air Corps and Naval Air Force training is concentrated.

Most of the jobs, 216, will be done by contract. Bids will be called for in 30 to 60 days. The WPA will do 87 of the jobs and 15 will be done both by WPA and contract work. CAA Airport Division Engineers will serve mainly as aeronautical advisers, while the Corps of Engineers will act in their usual supervisory capacity.

When the program is complete, many fields will be in higher classifications. There will be 246 more Class Three and 43 more Class Four, and 14 more Class Two fields.

About 60 percent of the federal money will be spent on non-labor supplies, including material and machinery. All federal money is restricted to the development of landing facilities, with the local government providing all other improvements.

Administrator Connolly announced that the airport work be directed by Lt. Col. Lucius D. Clay, assistant to the Administrator who was detailed from the Army last Fall to supervise airport defense work.

SPOT CHECKING

An unbustable container for dropping fuel and water with or without parachute from air planes is being developed by Army. It is made of plastic and canvas. In tests it has been dropped 100 feet.

U. S. aircraft payrolls reach $10,605,000 weekly, closing the first half of the year. During that period, 87,413 new jobs were provided. Total employment July 1 was 281,306; total engine, propeller and airplane floor space; 40,096,497 sq.ft.; backlog of unfilled orders: $5,136,759,573.

Mr. Allan Lockheed writes in to call attention to an error in the last issue of AVIATION, which referred to the dissolution of his company. Mr. Lockheed says, "In August, 1929, at which time I was Executive Vice President and Director of Engineering of Lockheed Aircraft Corporation, the company was merged, through an exchange of stock, with the Detroit Aircraft Corporation, at a valuation of substantially $3,000,000." Mr. Lockheed says he could see no chance of success under the merger, which he could not prevent, and that he resigned from Lockheed Aircraft Company. "Approximately 30 months after the merger, the Detroit Aircraft Company went into bankruptcy and shortly thereafter Mr. Robert Gross and his associates purchased the company," Mr. Lockheed says, "from the Federal Court for the sum of $40,000."

Airplane detectors, built in the United States, are now in use on the British Eastern front. They are similar to the British detector in use in England. The U. S. device detects and locates planes 50 miles away.

New York City is going to have another airport; 50 acres of land have been obtained in the Idlewild section of Queens, on Long Island. The new field will be used for miscellaneous flying and training, but will be available for transport when La Guardia is overcast.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

Short Summer Nights

An eye-witness report on Crete states that the glider exploit was insignificant. It was transport planes that did the trick, says this observer. The Germans littered the margins of main airports with crash landings, leaving the runways clear. When the field was captured they started a shuttle to the Greek mainland, with amazingly fast ground movement. Of course many troops, perhaps 10 percent, were injured or killed in the crashes.

The Stubblefield award goes to the high German Luftwaffe officer who told Collier's aviation correspondent how an air force ought to be organized. The Germans are anxious for us to have the greatest possible air striking power.

Construction of air bases in Brazil is confirmed by both General Marshall and by President Roosevelt. The lid is tight on further information, but indications are that the bases are being added to the Pan American Airways system with government money. Also, two islands far off the Brazilian "Hump" are being improved for air operations, apparently in a deal whereby the U. S. purchases more Brazilian products than heretofore. Little doubt exists that naval and air bases are under construction, with U. S. aid, in Scotland and Ireland, and at other foreign points.

Nazis never had the air force they bragged about, say qualified observers who now tell the story. They say American and other visitors were sold a scare story. Their estimate is that Germany started with 20,000 planes, of which 7,500 were available firstline combat. Inability of the Nazis now to fight in Western air as well as in Russia, makes the British believe they will not have to take another effective blitz.

The British are trying to stick to 20 mm. cannon for aircraft, on the ground that the 37 mm. gun is too heavy, that it fires too slow, that ammunition is too much load. American plane manufacturers who have made tests deplore this attitude. They say the 20 mm. gun often fails to penetrate German armor plate; that one 37 mm. hit will finish off any plane.

The flight strip tease goes on and on. Both houses passed a highway bill providing $10,000,000 for the fields by roads. But F. D. R. vetoed it. Not because of the flight strips but because the highway money was allocated by states as usual instead of according to defense needs. Much to the surprise of everybody, the House confirmed the President's veto by failing to muster the two-thirds vote. Political oracles say the strips will be appropriated for in another bill because General Marshall okayed the idea.

Few people realize how short the summer nights are in England. It doesn't get dark till after 10 p.m. Tourists go sight-seeing up to then. There are only four or five hours of night, which isn't very dark either, and that brightens into dawn between three and four a.m. A bombing trip to Berlin takes nearly eight hours. That's why Britain waits till fall to blitz the blitzers.

Alaska is a hotspot these days, with CAB, the Army and the Navy busy expanding aviation communication and rushing bases and airports. The assumption is that this country is fixing to ferry war planes over that route.

"Grasshopper Squadron"

Light airplanes are being further demonstrated in the Third Army Maneuvers at El Paso. Fourteen 65 hp. Aeroncas, Piper Cubs, and Taylorcrafts are donated, along with their commercial pilots, by the manufacturers. The planes have just completed successful tests with the Second Army Maneuvers held in Tennessee.

All the ships were tandem, allowing visibility in all directions for the pilot and observer. All carried two way radio equipment.

In Tennessee the main tests were on artillery fire; the planes used at El Paso were put to wider use. They received enthusiastic approval of Gen. Innis P. Swift, in charge of the maneuvers, who said they were the best type of message carrying equipment the Army has ever had. Swift said he radioed for one of these ships and it arrived on the spot in twenty minutes.

The ships amazed officers by their ability to land and take off anywhere needed. Engineer Corps found it could clear a landing strip on most any reasonably open ground in a matter of minutes.

Planes dropped their messages in special message bags with streamer. One pilot made a direct hit on a scout car in motion.

Air Support Command

Continued from page 111

This plan for support aviation requires no change in the principle that all types of units of the Air Force Combat Command must be trained and used in support of ground forces. When conditions make it necessary, support aviation may be used for special Air Force missions, in conjunction with naval forces or with ground forces other than those to which they are specifically identified.

An Air Support Staff, under the jurisdiction of the Air Force Combat Command, is being organized. Initially, it will be located at the Army War College, Washington. This staff will develop doctrines, tactics and techniques involved in air support operations.

It is contemplated that all observation squadrons will be transferred to Air Support Commands upon recommendation of the Chief of the Army Air Forces. For the time being, however, these squadrons will remain with the ground units to which they are now assigned.

THESE are Curtiss-Wright 21-B interceptor fighters lined up at Bandoeng airport, in Java. The Dutch have taken delivery on a number of these fast-climbing ships which have 1,000 hp. Wright Cyclone engines and deadly fire power.

Collier Trophy Meeting

First meeting of the NAA Collier Trophy Committee was held in Washington recently to select nominees for the 1940 award to be made this fall. The trophy is the highest honor in aviation voted each year for the most outstanding contribution to air progress successfully demonstrated in use during the year previous. Out of a list of some 18 candidates, 5 were selected for further consideration and detailed information on these 5 considered.

NYA Glider Division

Senator McCarran has introduced a bill to promote defense through the creation of a reservoir of potential airplane pilots and mechanics, by establishing within the National Youth Administration a Glider Division. It would sponsor the formation of glider clubs, furnish plans for glider construction.

CALLING NAMES

Robert C. Farrington, 59, chief mechanical engineer of the Austin Company, died on July 15th.

Godfrey L. Cabot, senior vice pres. of F.A.I., is now head of the F.A.I.

Lt. E. E. Davis, Assistant American Air and Naval Attache in London, has been missing since he left Gibraltar for London on May 23, aboard a bombing plane.

Victor E. Semran, formerly office manager for Kinner Motors, is promoted to secretary-treasurer.

William Lind, service manager of Menasco, completes a 22,000-mile, 70-day air tour of New Zealand, Australia, Philippines, Singapore and Dutch East Indies.

W. B. Marshall is promoted to sales manager of Conveying & Engineering Products Div. of Chain Belt Co., **B. E. Sivyer** to asst. sales manager, and **S. Y. Warner** to branch manager at San Francisco.

C. M. Rodman goes with Doolittle Radio as sales manager.

Archie A. Morris is Southern California representative for McKenna Metals Co.

R. S. Ernst represents Hele-Shaw Pump Division in Indiana, Wisconsin, and part of Illinois, with headquarters in Chicago.

Brig. Gen. Frank T. Hines and **Lindsey Hopkins, Jr.** are elected to the board of directors of Sperry Corporation.

L. L. Horchitz is named manager of B. F. Goodrich's new Los Angeles district, **H. A. Schultz** branch manager at San Francisco, and **C. M. Christensen** manager of the Denver district.

Milton Chapel is West Coast representative for Airwing Aircraft Fabrics & Tapes at Glendale, Cal.

Thompson Electric Co., Cleveland, got out a new catalog showing a lot of interesting electric and other appliances, and how to use them.

Charlie Planck, press man at CAA, had an article in Esquire on flying tiny models with house flies for engines. He gave a fly party at his home in Washington, where a lot of dignified people tried it.

Seldon Rodman edited "The Poetry of Flight" published by Duell, Sloan & Pearce, New York.

H. J. Symington, K. C., of Montreal is new president of Trans-Canada, succeeding S. J. Hungerford, who resigned.

Beech Aircraft Corp. has prepared a booklet entitled "On the Record." The book reviews the history of the company and traces its progress from 1932 up to the present time, when the company has promised to deliver more than $80,000,000 worth of Beechcraft planes to the Government.

William J. Timberman, sometime president of Dubois Aircraft, is appointed aviation sales manager for the Pittsburgh Plate Glass Co., handling its sales of glass and paints for aircraft.

Motorless Flight Institute Inc., has been reorganized as **Glider Flight, Inc.**

Lord Halifax, British Ambassador to the United States, visited the Northrop Aircraft Plant at Hawthorne, California.

K. D. Smith, is named assistant to T. G. Graham, v.p. of the B. F. Goodrich Co., of Akron; **A. W. Phillips** is appointed general superintendent; and **Harold Gray** assumes post of technical superintendent.

Daniel M. Watts, formerly management engineer for Bendix at South Bend, becomes factory manager for the Kaydon Engineering Corp., newly formed to manufacture special bearings.

John M. Lockhart is appointed assistant to E. Lee Talman, treasurer of TWA.

Sir William Douglas, Britain's fighting Air Marshall, was recently knighted.

Paul Hunt, American Airlines' salesman in Detroit, is also a cartoonist and draws covers for the Flagship News, house-organ.

Edward L. Biersmith is promoted to production manager for Columbian Steel Tank Co.

Griffith Brewer is elected president of Britain's Royal Aeronautical Society.

John D. Peace, Jr. is now connected with United Aircraft Products in charge of sales for Dayton and West Coast plants.

Maj. Gen. Millard F. Harmon is assigned to command the Second Air Force at Fort George Wright, Washington; **Maj. Gen. Lewis H. Brereton** to command the Third Air Force, Tampa, Fla.; and **Brig. Gen. William O. Ryan,** to command the Fourth Interceptor Command, March Field, Calif., and **Brig. Gen. Henry W. Harms** to command the U. S. Forces in Newfoundland.

Thomas F. Troxell is elected treasurer and a director of Copperweld Steel; **Sidney D. Williams** is made executive v.p. in charge of the Warren division; **William B. Klee, Jr.,** asst. secretary, is also made assistant to the v.p.

Robert H. Hinckley, Asst. Secretary of Commerce for Air, returns from a 2-weeks inspection trip to Alaska.

Coming Events

Sept. 5–6 Aircraft Structures Conference, Society for Promotion of Engineering Education, Case School of Applied Sciences, Cleveland, Ohio.
Sept. 11–15 Algonquin Park Air Cruise for 1941, Highland Inn, Algonquin Park, 160 miles north of Toronto, Canada.
Sept. 17–19 National Petroleum Association, 39th Annual Meeting, Hotel Traymore, Atlantic City, N. J.
Oct. 1–Nov. 7 Aeronautical Exhibition, Winged America. Maryland Academy of Sciences, Baltimore, Md.
Oct. 2–4 National Association of State Aviation Officials, Annual Convention, Providence, R. I.
Oct. 6–8 28th National Foreign Trade Convention, Hotel Pennsylvania, New York, N. Y.
Oct. 6–9 National Safety Congress, Stevens Hotel, Chicago, Ill.
Oct. 6–11 Exposition of Power and Mechanical Engineering, International Amphitheater, Chicago, Ill.
Oct. 12–15 American Society of Mechanical Engineers, Fall Meeting, Louisville, Ky.
Oct. 20–24 23rd National Metal Congress and Exposition, Convention Hall and Commercial Museum, Philadelphia, Pa.
Oct. 23–24 SAE National Fuels & Lubricants Meeting, Mayo Hotel, Tulsa, Oklahoma.
Oct. 30–Nov. 1 SAE National Aircraft Production Meeting (and Engineering Display), Biltmore Hotel, Los Angeles, Calif.
Oct. 31–Nov. 2 Aero Medical Association, 13th Annual Convention, Statler Hotel, Boston, Mass.
Nov. 13–14 SAE National Transportation & Maintenance Meeting, San Francisco, Calif.
Dec. 1–5 American Society of Mechanical Engineers, Annual Meeting, Hotel Astor, New York, N. Y.
Jan. 9–11 14th Annual All American Air Maneuvers at International Airport, Miami, Florida.
Jan. 12–16 1942 SAE Annual Meeting and Engineering Display, Book Cadillac Hotel, Detroit, Mich.

The best Pilots never Graduate!

THERE'S probably no such thing as a *perfect* pilot. For the speed of new developments in aviation rivals the speed of the new planes themselves.

The *constant* sharpening of a pilot's sixth sense—the Sense of Flight—demands far more than hours in the air.

To keep it keenly alert and abreast of newest techniques, the best pilots regularly return to trainers like the new Rearwin that brings them up-to-date.

On the instrument panel of this trainer, the experienced pilot sees those same familiar Kollsman faces found on great clipper ships, commercial airliners, and planes of the United States armed forces.

Precision pilots keep up-to-date with Kollsman Precision Aircraft Instruments!

* * *

Write for the informative 48-page booklet: *Facts About Kollsman Aircraft Instruments*. Full descriptions of flight and engine instruments.

CAPTAIN "DICK" MERRILL—first pilot to fly the Atlantic on a commercial round-trip—now flys Eastern Air Lines Silverliner between New York-Miami. In spite of having flown more than two million air miles he, like all Airline pilots, must every month check and re-check his ability to fly by instruments in Eastern's trainers maintained at New York and Miami.

THE NEW REARWIN TRAINER—is noteworthy for its tandem arrangement of two separate compartments, each with its own door and individual equipment. Kollsman Precision Aircraft Instruments are standard on the Rearwin Trainer.

LET'S GO! U.S.A. KEEP 'EM FLYING!

KOLLSMAN
PRECISION AIRCRAFT INSTRUMENTS
Division of
SQUARE D COMPANY
ELMHURST, NEW YORK • GLENDALE, CALIFORNIA
DETROIT, MICHIGAN

THE BELL AIRACOBRA *"Cannon on Wings"*

AMERICA'S ANSWER TO *Ground Monsters*

Crawling along in their tracks of terror come the invader's flame-breathing armored beetles. But America's defense can pierce their skins of steel—with the cannon carried in the nose of the U. S. Army Air Corps' Airacobra. The armor-shattering shells of the Airacobra's 37 mm. anti-tank cannon stop tanks which easily go through machine gun fire unharmed. Because the Airacobra is *the world's only single-engine fighter with such a cannon,* it provides an advanced weapon for stronger defense in conjunction with America's many other splendid fighting units. Picture the advantage of artillery whirling through the air at Aviation's fastest speeds, under the control of single pilots, with devastating accuracy. Slower land forces are at the mercy of their speed and maneuverability, and their fire power is available in places a thousand miles apart in a matter of hours. Now a noteworthy milestone in Aviation's progress, the Airacobra is a symbol of Bell Aircraft's future destiny.

BELL AIRCRAFT CORPORATION

Bell Aircraft Ordnance Division BUFFALO AND NIAGARA FALLS, N. Y.

LET'S GO! U.S.A. · KEEP 'EM FLYING!

Making Aviation History

New "Super-Stuka"

Capable of carrying a half-ton of TNT neatly packaged within its fuselage, America's newest high-speed, long range, heavy dive bomber, the Brewster SB2A-1, was demonstrated at Newark Airport recently. The ship is said to be more than 100 m.p.h. faster than the Stuka or any American dive bomber now in use and has twice the range and load carrying ability of the German type. It can fly non-stop from New York to Los Angeles. (Photo on page 111)

An all metal, midwing monoplane, the SB2A-1 is powered with a Wright double-row, 14 cylinder Cyclone engine rated at 1700 hp. Both the SB2A-1 and the "Bermuda" carry a crew of two, a pilot and a gunner. The gunner is housed in a power-operated turret at the rear of the ship. Special split flaps in the trailing edge of the wing act as brakes to slow down the bomber when diving on its target. Pilot and gunner are protected by armor plating and fuel and oil tanks are of the latest bullet-proof type.

Like the Brewster "Buffalo" fighter, the SB2A-1 was developed for the Navy for operations from the decks of carriers at sea. An export version of the new plane, called the Brewster "Bermuda", and designed for land-based operations, will be built in large quantities for the air forces of both Great Britain and the Netherlands East Indies.

Air Force in Maneuvers

Perhaps 1,000 planes and nearly 10,000 officers and enlisted men of the Army Air Forces will participate in this year's large-scale maneuvers, September 1 to 30, giving ground forces the greatest air support they have ever had in peace-time field training operations, the War Dept. states.

Dive bombers of the Army, the Navy and the Marine Corps will come down over the troops in simulated warfare that will be realistic to an unprecedented degree. Also light and medium bombers, fighters and observation planes will carry out combat missions in cooperation with more than 500,000 troops in various maneuver areas.

Air-ground cooperation was the basis for the formation of the Five Air Support Commands announced July 29. Troops will learn how their own planes support their operations and will learn to defend themselves against hedge-hoppers.

THE FIRST Rolls-Royce to come off the Packard production line. Great things are expected from Packard in building these engines.

RFC Bags Bauer

At last the United States Government, with the cooperation of the President of Colombia, has got rid of Axis aviation hovering around the Panama Canal. Paul von Bauer, Germany's ace air diplomat in Latin America since 1919, has been forced to abandon Colombia and his efforts to reorganize German aviation there, following the recent dissolution of the famous SCADTA system, whose pilots for years sailed around in view of the Canal Zone. Bauer is the latest bag in the RFC-financed Latin American effort to ground the fascists and Nazis. Bauer has moved to Chile where, trying to get cozy, he has made the government a present of an old German steamer which couldn't be moved out anyway, on account of the British blockade. The Department of Commerce says that all anti-American agents in South America will be hounded from place to place until they give up their activities.

4 Paratroop Battalions

The 9th Division, Ft. Bragg, is supplying 172 soldiers training for duty as parachute troops. This increase to 1,100 in number is expected to bring up to full war strength the 501st and 502nd Parachute Battalions. An additional 213 men will be selected from volunteers serving with the Eighth Division, Ft. Jackson. Two more parachute units, the 503rd and 504th Parachute Battalions, are scheduled for organization.

Acme

BRAZIL demonstrates Anti-Aircraft defenses. Crew of one of many anti-aircraft guns ringing Rio de Janeiro goes into action for benefit of Ass't Minister of War Gen. Dutra and high ranking Brazilian officers.

British Front Reports

Oliver Stewart, British aviation expert, says future will see super-bombers escorted by variety of specialized craft, in the manner of navy support for battleships. The bomber will be the striking weapon; then will come the medium bomber which is more maneuverable; then the long-range fighter, equal in mileage to the medium bomber; then the interceptor fighters—during the departure and last lap of the return. Production engineers will hate specialized aircraft, he says, but the fighting pilots will demand them.

RAF claims improved fighters can climb 5000 feet higher than usual, to tackle bombers at 40,000. In aerial warfare, altitude is everything. Some American experts are skeptical, and will wait and see what British craft do. Meanwhile, RAF claims that the German Messerschmit Me. 109 F cannot get up to the Boeing 4-engine bombers.

British airmen in Washington repeatedly say that Germany will be defeated with bombers; they want the American 500-bombers-a-month more than anything else. People ask why they don't blitz Berlin now. They say the nights are too short; its an 8-hour trip to Berlin. In September or October the big drive will start, and "There'll be a new word for 'Blitz'." Western Germany and the occupied coast countries are getting it now, day after day. Recent British visitors admit their country came awfully close to being defeated last September.

RAF gives unlimited praise to "all American bombers" from the Boeing down to the Lockheed Hudson. They call them "wizzard," which means "tops."

They brag on the "Tomahawks" — Curtiss P-40s, for their fast climb and striking power. The P-40s, they say, in press releases, have brought down some of the "best German planes," but privately they add that American fighters are not usually matched against the Germans over Britain but are used in the Mediterranean.

Merril C. Meigs, aircraft chief of OPM, said in London that the British are now equipped to receive and service all types of American planes. He said 80 percent of workers in some factories are women. Some of the new British bombers are coming out with American engines.

The World's Mightiest Bomber Depends On

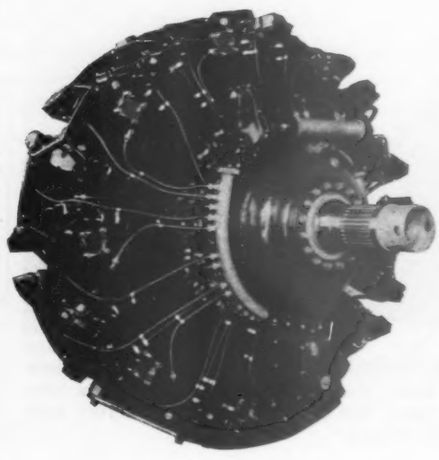
TIMKEN BEARINGS

Bendix Landing Wheel (minus tire) as used on world's biggest bomber. Timken Bearing Equipped.

The huge Bendix landing wheels of the Douglas B-19, the tires for which are each 96 inches in diameter overall, are mounted on Timken Tapered Roller Bearings. There are 2 bearings per wheel and each bearing is required to carry a load of approximately 20 tons. Each wheel is equipped with 2 brakes, 30 inches in diameter, 8 inches wide and operating at 1,000 pounds hydraulic pressure.

"Timken Rocker Arm Bearings are used in the 4, 2,000 H.P. Wright Cyclone 18 Cylinder Engines that give the big ship 66% more power than is possessed by any other bomber—8,000 H.P. as against 4,800, the next highest."

Timken Bearings are used in all military and commercial aircraft and in most small private planes.



Wright 2,000 H.P. Cyclone Engine equipped with Timken Rocker Arm Bearings.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; and Timken Rock Bits.

7423 Military Planes in First Half, 1941; 1460 in July; 19,000 Expected This Year

Washington (AVIATION Bureau)—U. S. Aircraft industry produced 7,423 military planes in the first half of 1941. This was over 1000 better than the total production of 1940. Here is the record, compiled by the Aeronautical Chamber of Commerce, for the past 12 months.

11,647 Planes

Here, month by month, is the record of rising warplane production in the United States during the 12-month period ending July 1, 1941:

1940		1941	
July	547	January	1036
August	586	February	972
September	670	March	1216
October	742	April	1389
November	779	May	1334
December	900	June	1476
Total	4224	Total	7423
Grand Total			11,647

Estimates from official quarters were that production of military craft during 1941 would be 18,000 to 20,000. This would triple the output of 1940, and would be 650 percent of the 1939 production of 2400 units.

The production for July was 1460 against 1476 in June. This slight decrease, instead of increase, was due to the long "Fourth" holiday, and to the present tightness of metals.

William S. Knudsen, OPM director general, after a Western inspection trip, said that in 1942 the United States will build 50 percent more military airplanes than any other country in the world. By the second half of next year, he said, the rate of production will be about 3000 units a month.

"Money doesn't mean anything . . ." he said. "Man hours is what we want."

There is no public information on how many of these planes have been delivered. "Hundreds" are being delivery-flown to Britain across the Atlantic and across the Pacific to Singapore and other British strongholds.

Douglas deliveries of military planes increased 30 percent in June over the previous month, the company reports, adding that that was 10 percent over the national increase.

Consolidated's total production for the first six months was nearly four times the company's total output for all of 1940. The company states that about 17 percent of all the U.S. aviation industry's business is now on Consolidated's books.

Wright Aeronautical Corporation produced 1,710,000 horsepower in June. The company states this was a new high American industrial record for mass production of aircraft engines. General H. H. Arnold, Chief of Army Air Forces, said Wright Aeronautical is rapidly approaching its peak of 1,780,000 horsepower a month, though it was not scheduled to attain this figure until November of this year. Wright engines power 98 different military models of airplanes.

GE Hydraulic Prop

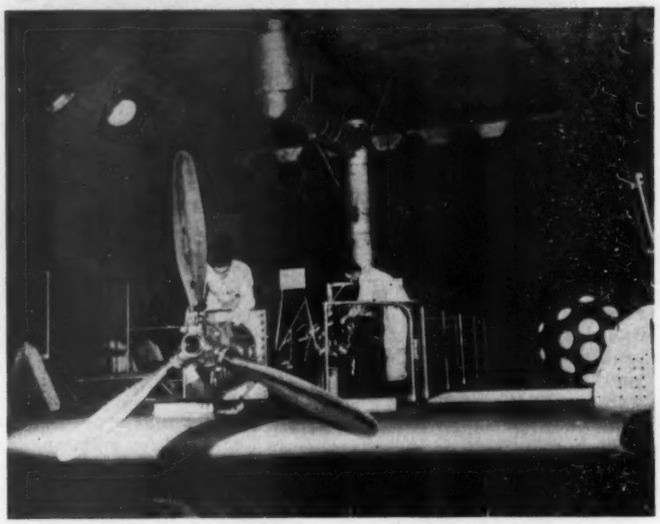
Aeroproducts Division of General Motors Corp., near Dayton, Ohio, is ready to start building a new-type hydraulic airplane propeller for the Army Air Corps.

Already, a new plant, tooled during the past year while experimental work continued, is working on a three-shift, six-day-a-week basis, with five different models of propellers in the testing stage.

More than 500 employees are testing propellers and completing the installation and setting up of tools and machinery. When operating at full capacity about 2,600 employees will be needed.

The plant has, designed and in test, all types and sizes of propellers necessary for installation on Allison liquid-cooled motors. In addition propellers for engines as powerful as 2,000 horsepower are in process of development.

A major advantage claimed for these propellers is the center mounting of the aircraft cannon permitted through use of this design.



GETTING SET for propeller test, Ray Bushong and L. G. Granger give final check before starting vibration test run of hydraulic propeller developed by Aeroproducts Division of General Motors.

Light Plane Production is Facilitated By Priority Rating for Essential Uses

Limits on the production of light planes are largely removed by a priority division ruling granting an A-10 rating to planes built for a large number of different civil uses. It is believed that under that new plan some expansion of production over last year's figures—perhaps up to 6,000 or 7,000 planes a year—will be permitted. This does not take into account the possibility that a substantial number of class 1 ships might be bought by the War Department for liaison use.

Under the new plan manufacturers are granted an A-10 rating on that portion of the supplies they buy which will go into planes for the following uses: CPTP training, airline instrument training schools, other schools approved by CAA, home guard units, pipe line patrol, state and city police, power line patrol, patrol activities for any governmental agency for CAA-approved experimental projects. The rating has been assigned to approximately twenty-six manufacturers of aircraft engines and radio equipment.

Moreover, although plane buyers must certify that they are buying a plane for one of the specified uses, this certification is only binding for ninety days or three-hundred hours service.

The new rating does not, of course, have any formal effect on the aluminum situation. Aluminum is now entirely subject to allocation and priority ratings as such don't mean much. Some three months ago an arrangement was worked out to give a limited poundage of aluminum to about a half-dozen manufacturers building planes for the CPTP program. Assignment of a new rating, although it does not affect this situation, clearly indicates intention to assign some aluminum to planes for other than CPTP use. This will probably apply to the more easily procurable types of aluminum, such as sheet and castings, but is unlikely to make

NORTH AMERICAN B-25 final assembly. In foreground are center sections; at left, beyond foreman's office, are front sections, and in the center, front, center and rear sections are being joined.

forgings and extrusions available.

Apart from aluminum, however, the A-10 rating regarded as helpful in buying other strategic and scarce materials such as nickel, steel, rubber, synthetic rubber, perhaps plastic-bonded plywood.

ASSEMBLY LINES

By Robert Colborn

Ford's "V" 12-cylinder liquid-cooled fuel-injection engine recently was given a test run, one year after the first blueprints were made. Company engineers hope the engine will deliver 1800 horsepower at takeoff. It will be several months before tests can be completed. The engine has been designed especially for facility of mass production.

Bell Aircraft is constructing a new $8,500,000 assembly plant at Niagara Falls Airport, to assemble Airacobras for the Army. The Buffalo plant will continue to turn out Boeing parts, Airacobras (boxed) for the British, ordnance equipment. The Niagara Falls plant will have 240,000 sq-ft of floor space, and a machine gun range, storage space, etc. Work will be speeded by two assembly lines, with dolly cradles hooked to chains moving ½ in. per minute. Word has got around that Bell has been producing Airacobras at a rate that astonished everybody who saw it.

Employment of women in defense jobs without lowering wage, hour and other working standards, is urged by Sidney Hillman, of OPM, in letters to nearly 200 airplane companies and other defense contractors. The aim is to avoid unnecessary importation of "out-of-town" labor, housing difficulties, and uprooting of families. Defense employers should indicate to the State Employment Service those occupations in which women will be used, and training agencies will establish courses for women in those occupations requiring training. Consolidated Aircraft was among the first to respond with a program of training women.

The B-19 was test flown daily to complete the required test period prior to final acceptance by the Air Corps. Operation is said to be entirely satisfactory. It is believed that more powerful engines will be fitted shortly, although full load tests are scheduled with the present power.

AS P-38 interceptors roll out to the combat squadrons, the Air Corps finds a need for sending some of its mechanics back to Lockheed for maintenance instruction. This is Irving Larson of the factory's education department and the first mechanics.

Lockheed C-56 and C-57 — all metal, midwing, cantilever transport monoplanes with twin tail assemblies and rectractable gears, are being tested by the Army. Each airplane has a wing span of 65 feet, 6 inches; is 49 feet, 10 inches long and has a gross weight of 17,500 pounds. Each carries a crew of two pilots. The C-56 carries two 1,-100 hp. 9-cylinder Wright engines. The C-57 has two P & W 1,200 hp. 14-cylinder engines. It is fitted with 14 standard airline chairs. Both planes have their commercial counterpart in the Lockheed "18 Lodestar."

First deliveries of the A-24, Army's new dive bomber, have been received by the Air Corps. Preliminary tests indicate the new bomber will outperform dive bombers now in use by foreign nations. The A-24 is designed to supplement the Air Corps' development of a well-rounded bombardment force, to include a sufficient number of all types of airplanes.

Telephone communication on the assembly line, between men working inside and outside fuselages, speeds production of Republic P-43 "Lancers." Hitherto, men had to crawl to first available opening to talk.

Airplane camouflage paint that can be removed and replaced with a different color to meet weather changes, and for change between night to day work, has been developed by a glass company. Of course you can't use paint that would wash off in water; the rain would get it. So the company worked out a paint that would come off when washed with a mixture of water and alcohol. That suited the Army all right, but the Navy didn't want to bother with alcohol. So the company whipped up a formula that comes off when washed with *hot* water.

Steps are being taken to triple the supply of fabricated alloy steel for aircraft manufacture before the end of 1942 OPM states. The increase is to be obtained by allocation of orders for maximum output from present facilities. Requirements of the aircraft industry have been determined accurately by government and Iron and Steel Institute.

An ambulance plane is being put into production by Aeronca. It is designed for use in coastal patrol as well as for carrying medical supplies. With slight structural changes it can be converted into an ambulance. It weighs 800 pounds empty. (Planes now in common use weigh upwards of 5,000 pounds.) Costs about $2,000 (the cheapest ambulance before this cost $15,000); can land in 600 feet of cleared land (previous planes have required at least 2,000 feet).

Douglas Aircraft Company has brought suit in the United States District Court to test whether it must pay the California sales-and-use tax on purchases of materials used for the manufacture of defense aircraft under the cost-plus-fixed-fee contracts entered into with the War Department. The tax amounts to three percent and has been levied by the state on all purchases by California individuals and corporations.

Magnesium castings will be produced in a plant being erected by Eclipse Aviation, division of Bendix, at Bendix, New Jersey. It is being financed through a recently approved Defense Plant Corporation grant of $1,079,000 allocated for expansion of magnesium production for defense. Eclipse supplies aluminum and magnesium castings for its own starter and other aeronautical accessories and for several aircraft engine manufacturers.

Boeing Aircraft Company completed all non-defense orders with delivery of the sixth and last of a fleet of Model 314 Clipper planes to Pan American Airways. The new Clipper will be used by PAA in starting expanded trans-Pacific service with three new flights between Honolulu and San Francisco.

Wage Stability Wavers Payscales Going Up

Efforts to stabilize wages in all Southern California aircraft plants broke down in early August when differences between negotiators made further conferences impossible. CIO, which represents North American and Vultee employees, held separate sessions from AFL union which was representing Lockheed-Vega employees. Since stabilization plan requires joint participation by all major unions and factories, the refusal of some groups to join in brought a deadlock.

The AFL International Association of Machinists representing Lockheed-Vega ap-

Wage Scales in California's Aircraft Plants as of August 9, 1941

Company	No. of Workers	Union Contract With	Starting Wage	Thereafter
Douglas	32,000	None	60¢	Increase 5¢ a month up to 75¢
Northrop	2,500	None	60¢	Increase 5¢ a month up to 75¢
Vega	5,000	A.F.L.	51¢	63¢ in 6 months
Lockheed	23,000	A.F.L.	51¢	63¢ in 6 months
Vultee	5,000	C.I.O.	60¢	Increase 5¢ a month up to 75¢
North American	10,000	C.I.O.	60¢	Increase 5¢ a month up to 75¢
Consolidated	16,000	A.F.L.	55¢	Increase to 75¢ after 4 months
Ryan	3,000	C.I.O.	55¢	Increase to 57½¢ after 2 months Increase to 62½¢ after 4 months Increase to 75¢ after 6 months

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WEATHERHEAD
FLEXIBLE HOSE
ASSEMBLIES
THE users of Weatherhead flexible high, medium, and low pressure airplane hose assemblies reads like a blue book of the aviation industry.
The list includes Beech, Bell Aircraft, Bendix, Boeing, Brewster, Consolidated, Curtiss, Douglas, Lockheed, Martin, North American, Northrup, Piper, Pratt-Whitney, Republic, Sperry, Taylor, Vega, Vultee, Vought-Sikorsky, Waco, Wright Aero, and many others.
Manufactured to Air Corps, Navy, or "AN" specifications, these assemblies are used for fuel and oil lines, instrument lines and hydraulic applications of all kinds. Odd sizes or combinations are made to special order. Send us your inquiries.
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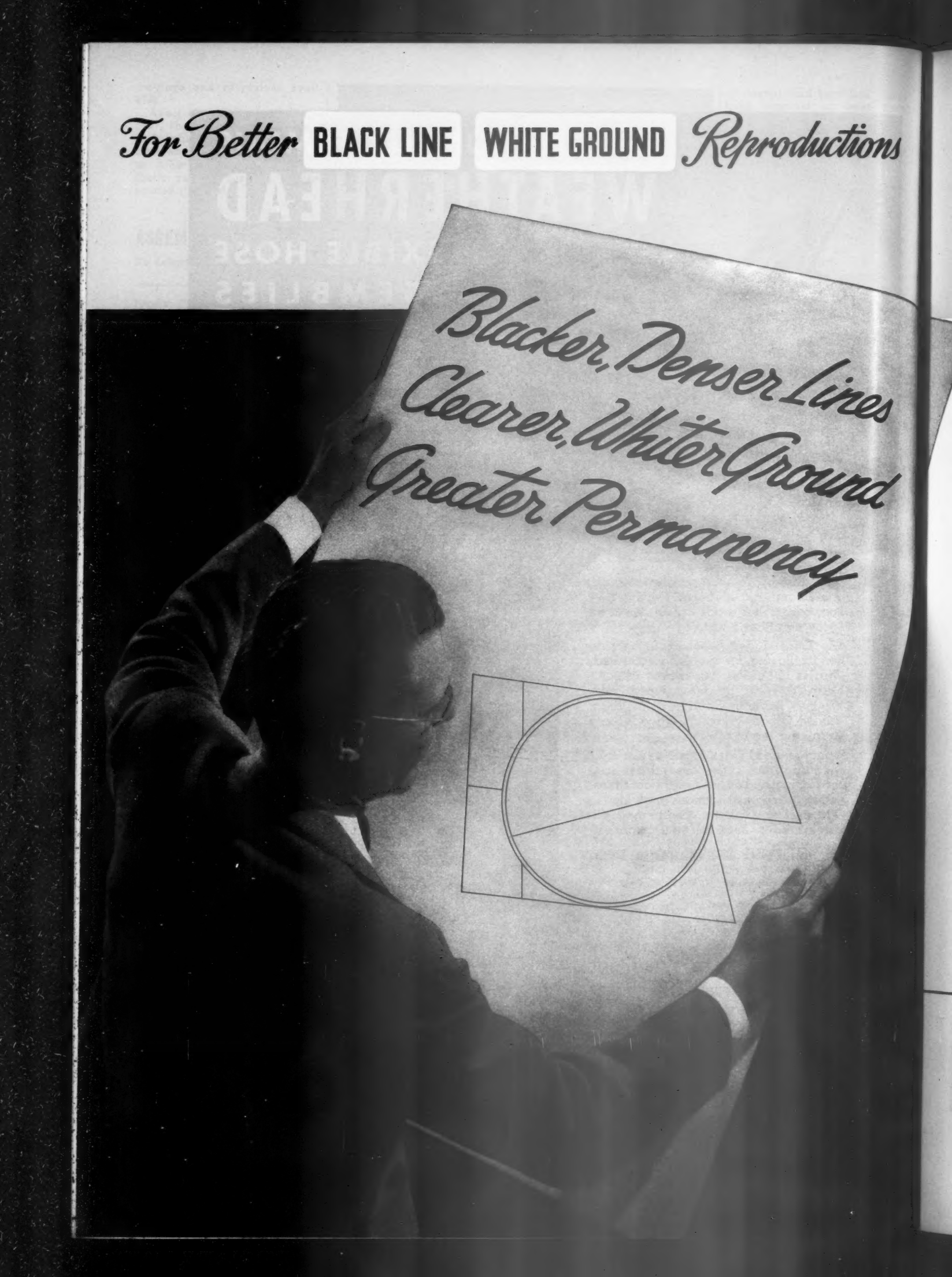
For Better BLACK LINE WHITE GROUND Reproductions
Blacker, Denser Lines
Clearer, Whiter Ground
Greater Permanency

DIETZGEN DIRECTO PRINTS

TRADE MARK

IN Dietzgen Directo prints, the direct method of reproduction is brought close to perfection. You get truly *black* lines, truly *white* background. Directo prints are more permanent than any you have ever seen .... or used. Directo prints are not subject to objectionable fading or discoloration with age or exposure to light. They *retain* their high quality, their contrasting sharpness and fidelity.

There's all the speed you can ever need in Directo paper. It can be printed faster than your operator can handle the paper. And no matter how fast or how slow you develop, the results are always uniform . . . *superior*. Voltage drops which can vary the speed of the developing machine can't vary the quality, the distinctness of Directo prints.

And you will appreciate the new convenience of the Directo reproduction method. The developer doesn't deteriorate. You don't have to "wash up" daily .... or bottle the solution. You just leave Directo developer in the machine, add fresh developer as the old is used up .... without fear of deterioration, streaking or smearing. And wet rollers won't mark the back of the prints.

And finally, the Directo process is entirely domestic. The chemicals used come from home sources, sure sources, controlled sources. The quality of Directo prints will *always* stay UP. No uncertain foreign sources to disappoint you .... no declining quality to cause grief and trouble.

In every way the Directo process and Directo prints are superior, satisfying, economical, convenient. You will want to try Directo prints at once .... to save the expense, trouble and delay that no doubt confront you now. Very satisfactory arrangements can be made either to demonstrate and prove Directo without cost or obligation, or to make this process available to you. Tell us what you want. And let us tell you all about Directo.

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- √ *A blacker, denser line.*
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- √ *The greatest print permanency you have ever seen.*
- √ *High-speed printing.*
- √ *Perfect, uniform results no matter how fast print is developed.*
- √ *Trouble-free developer. No nightly wash-up. No bottling of solution. No deterioration.*
- √ *Only domestic chemicals used. Assured supply of always uniform, standard quality.*

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pointed a fact-finding committee to conduct a stabilization survey of jobs and wages within that organization. Lockheed and Vega officials promised that this survey will develop equitable scales of wages between various classes of workmen, and also relative to other major aircraft companies in the region. Douglas also is conducting similar study. CIO continued independent negotiations with Vultee and other plants where it holds bargaining rights.

This was regarded as a major breakdown in Sidney Hillman's effort to put the aircraft industry under stabilization agreements, as reported in AVIATION for August. The outcome of the plan was unpredictable. Meanwhile the trend of aircraft wages was upward. Republic Aviation granted 10c increases to hourly workers and gains to salaried workers. United Aircraft announced increases affecting more than 25,000 employees in its three divisions, adding $4,200,000 annually to payrolls, exclusive of indicated adjustments in salaries.

Metal Specialty Offices

The Metal Specialty Company of Cincinnati, specialists in pressed metal and injection plastic molding for the aviation, automotive, refrigerator, and radio industries, has just completed a new air-conditioned office building adjoining its plant on Este Avenue, Cincinnati, Ohio. Officers of Metal Specialty include Vernon B. Chase, President; Harvey Johnson, Vice-President; and Arnold Tietig III, Treasurer.

Trainer Engines

Jacobs Aircraft Engine Company, Pottstown, Penna., major producer of aircraft engines in the 200 to 400 hp. range, has been awarded a $6,000,000 contract by the War Department. It is expected the engines will be used by the Air Corps to power advanced training planes.

Engines covered by the contract are understood to be the company's L-4MB model of 245 hp., which has been furnished to the Canadian government during the past year for similar training planes. Company also has large Canadian contracts for its 330 hp. engines.

Recent Awards

War Department

Vultee Aircraft, Inc., Downey, California, $14,518,707 for airplanes and spare parts.
Beech Aircraft Corp., Wichita, Kansas, $12,610,125 for airplanes and spare parts.
Bendix Aviation Corp., South Bend, Ind., $100,500 for wheel and brake assemblies.
Aro Equipment Corp., Bryan, Ohio, $103,425 for propeller hub assemblies.
Curtiss-Wright Corp., Clifton, N. J., $131,266 for propeller blade assemblies.
Curtiss-Wright Corp., Buffalo, N. Y., $142,445 for parts for airplanes.
Boeing Aircraft Co., Seattle, Washington, $212,090 for parts for airplanes.
Weston Electrical Instrument Corp., Newark, N. J., $249,246 for parts for aircraft instruments.
Crosley Corp., Cincinnati, Ohio, $729,995 for shackle assemblies.
Oneida Ltd., Oneida, N. Y., $546,158 for bomb shackle assemblies.
Jacobs Aircraft Engine Co., Pottstown, Penna., $6,006,577 for aeronautical engines.
Bendix Aviation Corp., Bendix, N. J., $5,561,200 for starter assemblies.
N. Backes & Sons, Inc., Wallingford, Conn., $237,136 for aircraft signals.
Essex Specialty Co., Berkeley Heights, N. J., $237,137 for aircraft signals.
General Motors Corp., Dayton, Ohio, $1,174,250 for landing gear assemblies.
Sparks-Withington Co., Jackson, Mich. $718,648 for hoist assemblies.
Yale & Towne Mfg. Co., Stamford, Conn. $185,294 for pumps and motors.
Kligore Mfg. Co., Tipp City, Ohio, $1,422,824 for aircraft signals.
Aviation Mfg. Corp., Williamsport, Penna., $16,945,430 for aeronautical engines.
Jack & Heintz, Inc., Cleveland, Ohio, $1,925,000 for airplane starter assemblies.
Curtiss-Wright Corp., Caldwell, N. J., $631,672 for propeller assemblies.
Chandler-Evans Corp., South Meriden, Conn., $921,500 for fuel pumps.
Kelsey-Hayes Wheel Co., Detroit, Mich., $531,318 for oxygen cylinders.
Curtiss-Wright Corp., Caldwell, New Jersey, $563,148 for governor assemblies.
United Aircraft Corp., East Hartford, Conn., $200,000 for engines.
Republic Aviation Corp., Farmingdale, N. Y., $781,946 for maintenance parts.
Lord Manufacturing Co., Erie, Penna., $695,599 for maintenance parts.
Wright Aeronautical Corp., Paterson, N. J., $4,338,093 for parts for engines.
Sperry Gyroscope Co., Inc., Brooklyn, N. Y., $526,231 for maintenance parts.
United Aircraft Corp., East Hartford Conn., $1,445,769 for maintenance parts.
North American Aviation, Inc., Inglewood, Calif., $1,360,505 for maintenance parts.
Consolidated Aircraft Corp., San Diego, Calif., $568,087 for maintenance parts.
Vultee Aircraft, Inc., Vultee Field, Calif., $1,374,115 for maintenance parts.
Independent Engineering Co., O'Fallon, Ill., $618,000 for portable generators.
Ainsworth Mfg. Corp., Detroit, Mich., $179,982 for shackle assemblies.
Boeing Aircraft Co., Seattle, Washington, $2,872,679 for maintenance parts.
Glenn L. Martin Co., Baltimore, Md., $3,666,020 for spare parts.
Consolidated Aircraft Corp., San Diego, Calif., $4,003,940 for spare parts.
Aerial Machine & Tool Corp., New York City, $124,920 for mount assemblies.
Air Cruisers, Inc., Clifton, N. J., $143,652 for cylinder and valve assemblies.
Glenn L. Martin Co., Baltimore, Md., $540,887 for turret assemblies.
Chandler-Hill Corp., Detroit, Mich., $535,750 for fuel pumps.
General Motors Corp., Indianapolis, Ind., $195,300 for aeronautical engines.
Douglas Aircraft Co., Inc., Santa Monica, Calif., $1,524,863 for spare parts.
Harrisburg Steel Corp., Harrisburg, Penna., $946,500 for cylinders, gas.
Thompson Products, Inc., Cleveland, Ohio; $861,000 fuel pumps.
General Motors Corp., Indianapolis, Ind., $349,637 for parts for engines.
Rolls-Royce, Inc., Detroit, Mich., $772,287 for ball and roller bearings.
Sperry Gyroscope Co., Inc., Brooklyn, N. Y., $711,965 for spare parts for automatic pilots.
Lockheed Aircraft Corp., Burbank, Calif., $694,477 for spare parts.
Curtiss-Wright Corp., Robertson, Mo., $390,201 for maintenance parts.
Ryan Aeronautical Co., San Diego, Calif., $146,834 for maintenance parts.
Beech Aircraft Corp., Witchita, Kansas. $164,303 for maintenance parts.
General Motors Corp., Indianapolis, Ind., $195,300 for engines.
Curtiss-Wright Corp., Buffalo, N. Y., $113,784 for maintenance parts.
Continental Motors Corp., Muskegon, Mich., $106,827 for cylinders and ring pistons.
Aviation Mfg. Corp., Williamsport Penna., $1,048,453 for aircraft engines.
Bendix Aviation Corp., Bendix, N. J. $928,329 for supercharger regulator assemblies.
Spriesch Tool & Mfg. Co., Inc., Buffalo. N. Y., $372,100 for shackle assemblies.
Elastic Stop Nut Corp., Union, N. J., $147,608 for assembly nuts.
United Aircraft Corp., East Hartford, Conn., $171,947 for aeronautical engines.

Pen or Pencil

We could have brought out a pencil cloth when we introduced Micro-Weave Tracing Cloth, but we didn't because we were not satisfied with a "just as good" product. We wanted something better, and now we have it — sufficiently better to prove itself on the drawing board. Micro-Weave Pencil Cloth is made in a new way, and it has a surface with a real pencil affinity — you try it, and you will realize how much of an understatement the word "better" is.

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Canadian Aviation News

By James Montagnes

Canada's production of aircraft in the second three months of 1941 was 25 percent greater than during the first quarter of 1941, and ten times greater than the entire 1939 output, according to Hon. C. D. Howe, Minister of Munitions and Supply. Output for the first six months of 1941 exceeded the total for all of 1940. In terms of numbers, the monthly production is now declining because Canadian plants are turning from the production of training craft to that of service craft, and also because plants already producing service planes are changing their output to meet new needs. In addition, the Canadian industry is expanding to meet overhaul and repair needs. This is the result of the tremendous increase in the number of aircraft in service in Canada, and future deliveries from England, both for the Joint Air Training Plan and for Royal Air Force schools in Canada. Over $4,000,000 above expected expenditures on service buildings and equipment has had to be authorized. During the second quarter more than 200 aircraft were received from the United States and nearly 300 from the British Air Ministry for the Air Training Plan.

Herbert J. Symington, K.C., has been appointed president of the publicly-owned Trans-Canada Air Lines, to succeed S. J. Hungerford, president since its inception. Mr. Symington has been on the board of TCA since its start, flew across Canada in 1937 from Montreal to Vancouver, when TCA was being started.

Air bases being built from Edmonton, Alta., to Whitehorse, Yukon, will be in use by autumn, according to J. A. Wilson, director of air services, Department of Transport, Ottawa. The chain of bases are being carved out of virgin bush in the hinterland of British Columbia as part of the work of the United States-Canada Joint Defense Commission. All radio stations will be finished this autumn. Considerable difficulty is being encountered in getting supplies into these remote wilderness airports, requiring freighting in of every type of equipment and man power necessary to build these airfields.

Canadian airplane plants early in August received orders for 1,000 airplanes valued at $25,000,000, according to an announcement by Munitions and Supply Minister C. D. Howe at Ottawa. Canadian Car and Foundry will manufacture 400 Hurricanes at the Fort William, Ontario, plant, after which it will turn out single engine Harvard fighters at the rate of 80 a month for an indefinite period. An order for 500 Harvards is being given Noorduyn Aviation Ltd., Montreal. The new orders will keep the two plants working at capacity well into 1943.

These orders bring airplane orders in recent months to $60,000,000. National Steel Car Corp., Hamilton, Ontario, is working on 200 Martin B-26 bombers. Canadian Vickers Ltd., Montreal, has an order for 39 PBY airframes. These flying boats will replace the Stranraer flying boats. Canadian aircraft plants are now turning out 40 planes weekly, as compared to 50 a year four years ago, Ralph P. Bell, Dominion director of aircraft production stated at Halifax on August 5.

Use of air mail service in Canada has increased greatly in the past year, the amount of air mail carried on Trans-Canada Air Lines in June, 1941, jumping to 118,942 pounds as against 68,270 pounds a year ago. Air mail poundage has been going up every month.

Acme

PASTORAL REPAIR SHOP used for overhauling Consolidated Catalina engines by ground crew at British operational base.

Two-Day Trans-Pacific Airline?

A two-day Pacific airline service between San Francisco and Sydney, is predicted by Lester Brain, former pioneer airmail pilot and leading Australian airline official, following the service flights of the Consolidated PBY flying boats to Australia. The Catalinas, flying only in daylight, crossed the Pacific in four days to join the Royal Australian Air Force Coastal Command patrols.

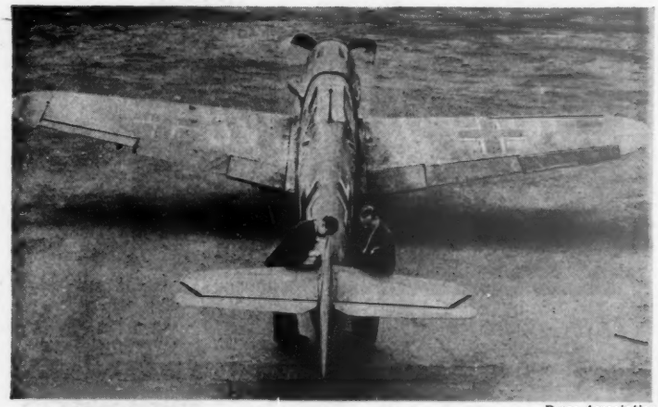
In peacetime, as pointed out by Brain, no difficulty will be experienced in making the U.S.-Australia run a two-day schedule. In 1929, the late Sir Charles Kingsford Smith flew the Southern Cross across the Pacific in 82 hours, 20 minutes.

Junkers Floor Level Assembly

A German method of production, used in the manufacture of wings for the Ju. 88 bomber, is reported to result in savings of space and time by use of pits or runways cut into the factory floor.

Usually scaffolding for supporting the larger parts of an airplane not only takes up a great deal of space, but also restricts the activities of the mechanics who are forced constantly to mount and dismount from ladders. In the Junkers method, the landing wheels, in their unretracted position, support the entire wing during the installation of engine and deicing equipment. The wheels run along in the pits in the floor at such a height as to permit the work to be carried on at floor level. The system affords the advantage of clear floors, and the wings can be rolled forward in line without delaying for clearance operations. In addition, engineers and inspectors can more easily and quickly go through their checking, not having to clamber around a lot of scaffolding to reach what they want.

A further advantage is that the method permits a low roof as a partial camouflage from the air and reduce the effects of blasts from bombing. Construction of this type of floor undoubtedly is more expensive than a level floor.



Press Association

LATEST Messerschmitt to be brought down over England is Me. 109F. Powered with the super-hotted DB 601 engine it is reported having a top speed of 380 m.p.h. at 21,000 ft. and service ceiling of 38,000 ft. British say it can't reach Flying Fortresses which they are now using over the Continent.

FIRST essential in the expansion program of the U. S. Army Air Forces is the primary flight instruction of Aviation Cadets. With the current quota of training 30,000 new pilots yearly, Ryan ST military trainers are contributing full measure to the nation's air strength by rolling from production lines to flight lines in ever increasing volume. The new Ryan PT-21, illustrated, is the latest in a distinguished series of trainers proven superior by extensive service with the U. S. Army Air Forces and the air services of friendly foreign nations.

RYAN AERONAUTICAL COMPANY
Lindbergh Field San Diego, Calif.

RYAN PRIMARY TRAINERS
IN VOLUME PRODUCTION FOR U. S. ARMY AIR FORCES AND U. S. NAVY

SUDDEN BIG FIRES

Need Instant

BIG CONTROL

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Because this method is engineered on *known factors,* Cardox Extinguishing Systems can be planned to match the growth of the blaze within the period required for automatic detection and release of sub-zero carbon dioxide. This means that *enough* CO_2 can be discharged to overwhelm as much fire as the hazard will develop in the short time required for release.

Fire protection on this scale originated with Cardox. Its contribution to your industry is beyond calculation. Learn the details from the Cardox Data File sent on request to technicians and executives.

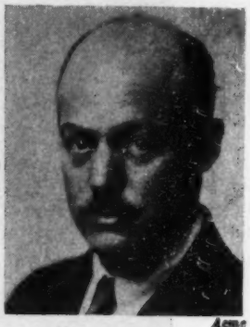
CARDOX CORPORATION

BELL BUILDING • CHICAGO

LINCOLN R. SCAFE, a General Motors executive for 19 years, is made gen. mgr. of the Glenn L. Martin-Nebraska Co. He will take charge of the new Omaha plant producing B-26 bombers.

BRIG. GEN. RALPH ROYCE, who has been serving as Asst. Military Attache for Air at London, is appointed Military Attache for Air to Great Britain, succeeding Brig. Gen. Martin F. Scanlon.

From his Mitchel Field, N. Y. headquarters, MAJ. GEN. HERBERT A. DARGUE, new Commander of the First Air Force, will command the air bases and the combat forces stationed in the Northeast



Acme

Last issue Major Gardner told of DR. J. C. HUNSAKER'S (l.) great influence on the founding of AVIATION and the forming of its policy. It is gratifying to hear of his two most recent appointments: Chairman of NACA, succeeding DR. VANNEVAR BUSH (r.); and coordinator of research and development for the Navy Dept. Dr. Bush is now director of the Office of Scientific Research and Development.

C. R. Smith, president of American Airlines, announces that MAJ. REED G. LANDIS, regional vice pres. of Chicago, has been loaned to the office of Civilian Defense and is now in Washington.

To become works manager of the Nashville Division of Vultee Aircraft, ROBERT MCCULLOCH has resigned as factory manager of North American Aviation. He has had 18 years in aircraft.

CHARLES H. COLVIN is Acting Chief of the Instrument Division of the U. S. Weather Bureau at Washington, and also serves as a vice president of the Institute of the Aeronautical Sciences.

Bowlus Sailplanes, which plans a large-scale increase in plant and personnel, has added ROSS McCOLLUM to its board of directors. He is president and general manager of National Oil Co.

Decked in leis, EDWARD H. FORREST takes over his new duties as United Air Lines' traffic representative in Honolulu. With the line since 1936, he has had three years in the Far East.

Legal matters for Republic Aviation Corp. will be handled by JOHN J. RYAN, newly appointed counsel. He has been with Bleakley, Platt & Walker, who remain as general counsel for Republic.

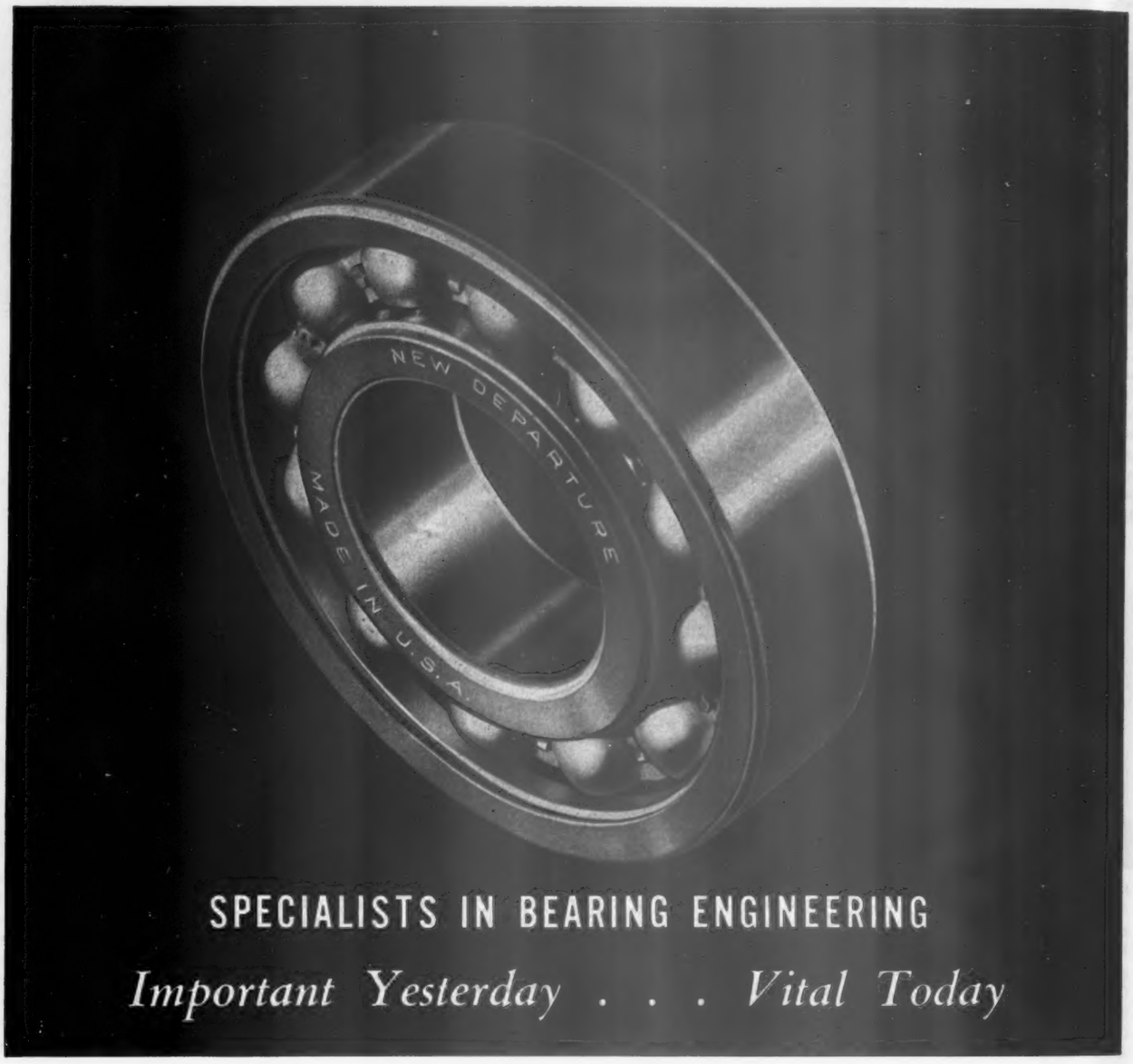
For his great contributions to aeronautics as both engineer and test pilot, W. K. EBEL, vice president of Glenn L. Martin Co., received a Plaque of Honor from the Union Trust Co. of Maryland.

Dick Whittington

Appointment of PAUL R. JORDAN as sales manager of Harvill Aircraft Die Casting Corp. is announced by H. L. Harvill, pres. He was previously account executive with West-Marquis advertising agency.

ALEC REID, of Northwest Airlines, has been promoted to district traffic manager for the line in Spokane. He succeeds Dan Hutchins, who was transferred to Portland to succeed Guy Talbot, resigned.

Congratulations to AL MOONEY on his 16th anniversary in aviation. He started with Alexander Aircraft as draftsman in 1925; is now vice president and chief engineer for Culver Aircraft.



● There is scarcely an industry of importance today that is not making a *better* product, *faster* and with *greater efficiency* because of work done at strategic points by New Departure bearing engineers . . . experienced specialists in the design and application of anti-friction bearings.

New Departure, Division of General Motors, Bristol, Connecticut; Chicago, Detroit and San Francisco.
Nothing Rolls Like a Ball

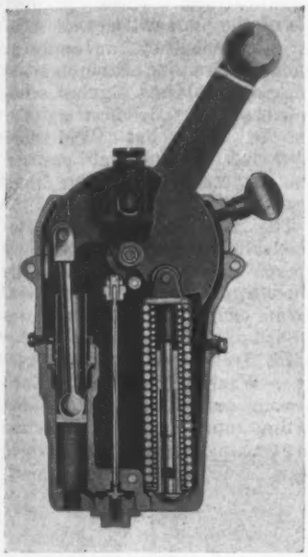
For factory aid and shop training courses ask for the New Departure Shop Manual on the handling, mounting and maintenance of ball bearings. Data books for engineers and designers available upon request. For bearings in full size section please ask for layout folder, LF. . . .

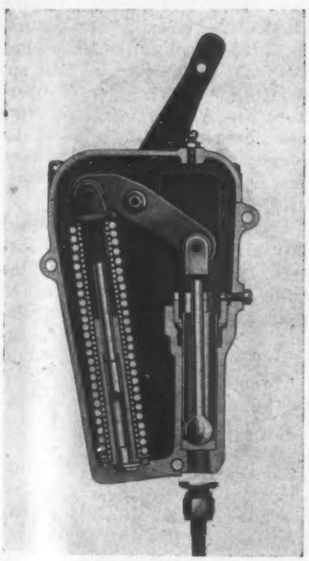
New Departure

BALL BEARINGS FOR DEFENSE

Hydraulic Exactor Control

An increasing number of Hydraulic Exactor Controls made by Sperry Products, Inc. of Hoboken, N. J. are being used in multi-engined airplanes. Among the British ships using this equipment are Stirling bombers, Sunderland and Lerwick flying boats, Flamingo transports, Hereford, Whitley and Wellington bombers. This equipment is also used at most Air Corps Depots, Naval Air Stations and on several U. S. airplanes.





The Control consists of two elements. The transmitter, in the upper photograph, and the receiver, shown in the lower picture. The receiver delivers through its lever (at the top) the work applied to the transmitter. The only connection is the single tube between the two members.

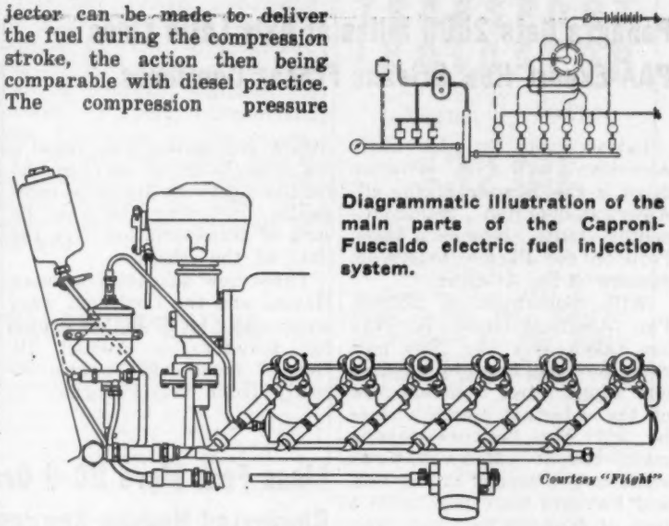
The cylinders of both parts are fitted with a trunk type piston, fluid tightness being insured by a specially packed gland. As cylinders and pipe are completely filled with liquid, a movement of the transmitter handle immediately results in action in the receiver. Pistons are connected by rod and radial crank arm to their shafts. Fluid is kept under pressure by means of opposing springs acting on the pistons.

The lower end of the transmitter cylinder communicates with a reservoir through a spring loaded valve. Normally this valve is closed but when the operating lever is moved to the up position, the final few degrees operates the valve mechanism and opens the valve against the action of the spring. The system is then open to the reservoir and pressure is instantly released. Any variation in volume is automatically compensated for, a deficiency being made up from the reservoir or an excess being driven out by the receiver piston which, on release of the pressure, is forced to the bottom of its stroke under the action of its spring. The initial backward movement of the transmitter allows the valve to close and any further movement will be reproduced at the receiver.

Electric Fuel Injection

A recent issue of the British aviation weekly, *Flight*, carried a description of a successful fuel injection system for automobiles which might be applied to aircraft engines.

Used on an Italian racing car, the Alfa-Romeo, in 1940, the system is known as the Caproni-Fuscaldo. Basic principle is an external tube containing a very small and light valve operated electrically. Apparently it may be operated in two different ways: the injection valve may be placed in the branch of the induction pipe, immediately before the inlet valve, or a small pipe can be led direct to the cylinder wall somewhere in the combustion chamber. When the injector is placed in the induction pipe, the valve opens during the induction stroke and the fuel mixes with the incoming air, being admitted through the inlet valve to the cylinder. If the direct injection system is used, the injector can be made to deliver the fuel during the compression stroke, the action then being comparable with diesel practice. The compression pressure against which the fuel is injected is, of course, a good deal lower, and spark ignition is used.



Courtesy "Flight"

Diagrammatic illustration of the main parts of the Caproni-Fuscaldo electric fuel injection system.

General arrangement of the injection system as installed in an Alfa-Romeo racing auto.

The basic advantage of the Caproni-Fuscaldo system seems to lie in the use of the small electrically operated valve of the injector. Although valve dimensions are unavailable, it is known that in the injectors used in the Alfa-Romeo racing car the valve lift was only 0.2 mm., and as the valve was very light, operating speeds were not limited by inertia forces.

Briefly described, the injector valve is housed in a small tube, with a small elector magnet above it. Electric current is passed to the magnet by way of a distributor, which can be run off the camshaft. When current passes, the valve is lifted immediately, and as soon as the current is cut off by the distributor arm leaving the segment, the valve closes under the pressure of the spring and the fuel is cut off. The timing of the injection obviously can be controlled by the distributor, and the amount of fuel admitted can be governed by controlling the amount of valve lift, either automatically or by hand. Accurate control of fuel admission, it is claimed, has been obtained down to periods as short as 1/1,000th of a second.

A more powerful pump is needed to deliver fuel to the injector valves for direct injection into the combustion space, but as the compression pressures in aircraft engines are not as high as those in diesel engines, there should be no difficulties on that account. It is possible that this electrically operated injector valve might be worth study for application in the aircraft engine field by engineers in the country.

Vapor Lock Danger Eliminated

Studies by the National Bureau of Standards, Department of Commerce, have developed information which has made possible the design of fuel systems for aircraft that largely eliminates the danger of vapor lock caused by the boiling of gasoline.

Vapor lock tends to develop in engines when climbing rapidly to high altitudes, particularly during hot weather. Test by the services and the industry indicated that the pump in the fuel system was most likely to cause boiling of gasoline. By placing a second pump in such a position that the fuel could be moved with the least suction, they found this hazard measurably reduced.

Larger and better placed fuel lines also were suggested as a result of the Bureau of Standard's tests, which covered the reducing valves, operating valves, and all kinds of fittings as well as the piping system itself. Each valve and fitting was found to have an individual resistance to the flow of gasoline and vapor. By analyzing all of them the experts found they could come close to determining the flow rate of the system as a whole and devise improvements.

While the vapor lock problem has not wholly been solved, real progress has been made and the recommended changes in the design of fuel systems have resulted in more dependable performance.

Panagra Gets 2000 Miles of Axis Latin Lines
PAA-Export-New Orleans Fracas Continues

Latest event in the Latin American anti-Axis aviation drive is the opening of the all-American-operated transcontinental route between Lima, Peru on the Pacific, to Rio de Janeiro on the Atlantic.

With cooperation of Bolivia, Pan American-Grace Airways has taken over the 2600 mile route formerly flown by the German Lloyd Aereo Boliviano, one of the oldest of German lines in SA. The Bolivian government bought enough German stock to get control of the line, and Panagra later negotiated a loan of $600,000 by which Nazi interests were completely eliminated, new American airplanes installed, and an airport, radio and weather program instituted.

On remaining routes of the Lloyd Aereo Boliviano in Bolivia—some 2200 miles—rapid nationalization is under way.

Pan American has added a new schedule across the Caribbean Sea from Miami to Barranquilla, Colombia, via Cienfuegos, Cuba and Kingston, Jamaica. This makes three round trips weekly on this route, and this service, with the non-stop flight from Miami to Balboaz, Canal Zone, makes a total of 17 schedules weekly which Pan American is running to South America. The growing demands of defense travel have necessitated these increases.

Meanwhile, Pan American and American Export, in another of their battles for routes connecting the U.S. and South America, along with a lawyer of the Civil Aeronautics Board, have set New Orleans agog.

Both lines applied for permission to fly from New Orleans to the Canal Zone. A lawyer for the Board, filing an opinion with the CAB examiner said there is no need for the line because there is "least degree of community interest" between the two proposed terminals. Congressmen and newspapers of New Orleans jumped on this phrase, and have repeated their arguments for a line out of New Orleans "serving the whole Mississippi Valley" to South America, and protesting present necessity of going either to Miami, Brownsville or Los Angeles to board an airline plane going south.

CAB on August 25 held hearing on the joint application of PAA, the Matson Navigation Company and the Inter Island Steam Navigation Co., regarding interchange of services and facilities between the three companies, including the sale by each of transportation over the lines of the others.

Three new schedules between Hawaii and the Continent were announced by Pan American for inauguration August 10. One of these will operate directly from San Francisco to Honolulu; another, during the same week, from San Francisco through Los Angeles to Honolu; and a third, on alternate weeks from San Francisco direct to the Islands. These schedules will double existing service by Clipper to the Islands.

An unusual load has been placed on this leg of the trans-Pacific route by the re-routing of passengers and mail from the Orient and Australasia to Europe.

PAA's application for a line from Los Angeles to Mexico City was recently denied.

Lines Fear More DC-3 Grabs for the British
Converted Hudson Suggested, Also Lodestar

Washington (AVIATION Bureau)—Word reaches here from airline operators that they are more disturbed by the threat of more requisitions of DC-3s for the British than they are by the loss of those already taken. The recent increase in hours in the air for each plane has not caused serious trouble.

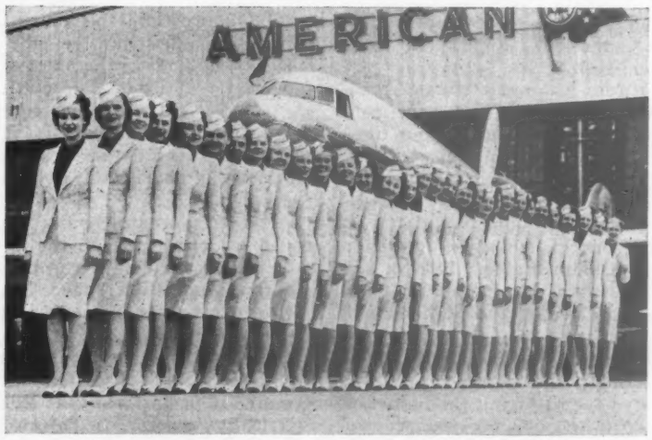
Worried U.S. line operators at least know that London has heard that all is not moonlight and roses on this side. AVIATION is told that Churchill himself took under advisement the proposal that Lockheed Hudsons are easily convertible for the transport service that Britain needs.

The Lockheed "14", from which the Hudson bomber was developed, is no longer in production and so is not available.

It has been suggested, unofficially, that the British might order Lockheed Lodestars for their transport needs. These are in production, and it is understood 20 of them, specially fitted as troop transports, were recently sold to the Dutch East Indies.

The airlines are hoping that something of the kind will be done and that they can keep their remaining DC-3s, and get all they need during the winter and spring for the big defense travel next summer. Vacation loads would have been much bigger this summer than they are, had the business been pushed.

The public, though of course not apprised of the situation which caused the drastic requisitioning of planes, has shown sympathy for the lines, as has Congress and many publications. The Scientific American in August gave its lead position to a plea that the airline planes are more useful to the anti-Axis cause where they are than anywhere else in the world.



FIGURES PROVE that 95 percent of these new American Airlines stewardesses will be married in two years. We can see why. These lovlies just finished training at N. Y.

Maintenance Rating Plan Available to Air Lines

To provide a sure supply of maintenance and repair parts for essential industries, OPM's Priorities Division has set up a Maintenance and Repairs Rating Plan for about 150,000 producers, manufacturers and agencies in nine industrial classifications. Those granted use of the plan will get an A-10 rating which they can apply to their orders. "Commercial air lines maintaining regular scheduled service" is first on the list of nine, but OPM told AVIATION this initial position has no more advantage than any other.

The A-10 rating is not automatically available. Before any person can use the rating he must apply for it on a special form: PD-57. Write Priorities Division, Maintenance and Repairs Section, 462 Indiana Avenue, Washington, D. C. Each person or agency granted the rating must agree to its terms in writing, a copy of which would be filed with the Priorities Division.

Exemption for Alaska

Acceding to requests from the Alaska Territorial legislature, the Civil Aeronautics Board has delayed its decision on the applications of 39 aircraft operators in Alaska, pending further hearings to be held by Board officials meeting there. New legislation may be recommended.

The Alaskan Legislature asked that air transportation in that part of Alaska west of the Yukon Territory, Canada, be exempt from economic regulation by the Board until the Legislature could present certain recommendations to the Board on the subject of public convenience and necessity in that part of Alaska.

The Board recognizes the differences between the air operations in Alaska and elsewhere. Regularity of service, for example, is quite different in Alaska, and most of the 39 carriers, while they do not operate on a timetable basis, do provide "regular" service. Under the exemption order, these operators may now proceed to de-

velope definite, regular service without prejudicing their positions under the "grandfather" clause. Operators of mail routes may continue rendering this mail service until the Board has disposed of the applications finally.

British in Baltimore

British Overseas Airways Corporation will use Baltimore as its United States terminus for the duration of the present emergency, or until it establishes elsewhere its principal maintenance, overhaul and repair base.

This ruling by the Civil Aeronautics Board recognized the claims of the British corporation that the situation at Port Washington in New York was not suitable for basing their operations there, and that the marine base at LaGuardia field is adequate but is at present used to capacity.

The route established by the Board's ruling is to "a terminal point" in the United Kingdom of Great Britain and Northern Ireland, via Canada, Newfoundland and Ireland, or via Bermuda, and the number of round trips shall not exceed two per week, unless additional frequencies are authorized by the United States government.

The ruling was approved by the President July 31, 1941, and British shops immediately began using the port at Baltimore, to which their maintenance base facilities and personnel have been moved.

Canada's oldest commercial airfield closed at the end of July, 1941, after being in continuous service since 1910. First flights were made at the Weston Airport, at Keele Street and Trethewey Drive, Toronto, by Count Jacques de Lesseps in 1910. The airport has seen many types of planes since that first model. A growing residential area near the old airport finally forced it to close. A farm couple, after living within sight of the field all these years, having witnessed the first flight, finally decided to try out these airplanes on the last day the field was open. In their eighties, the couple enjoyed the flight, wished they had started earlier.

Cincinnati Accident

Probable cause of the accident to American Airlines' Trip 20 on March 10, 1941, near Cincinnati was the error in judgment of the pilot in continuing an attempt to land during a period of restricted visibility from the cockpit due to heavy precipitation, CAB reports. A substantial factor, increasing the pilot's difficulties and the liability of error in judgment, was the inadequacy of the system of runway lighting on Lunken Airport, Cincinnati, Ohio, according to the report. The accident resulted in partial destruction of the aircraft and minor injuries to nine passengers and three members of the crew.

TRANSPORT DOINGS

TCA's fleet of 20 aircraft is cut 10 percent as Canadian government requisitions 2 transport planes. Engages girls to replace airport passenger agents called for military service. Company is servicing planes of four U. S. companies in Canada; Northeast at Moncton, N. B.; American Airlines at Toronto and Windsor, Ont.; Northwest at Winnipeg and Western Air at Lethbridge.

Penn-Central was heard by CAB, July 23, on whether its mail rates are fair and reasonable; also July 30 on the petition of Elizabeth City, N. C., to be included as a stop on route No. 51. All company air hostesses are issued license certificates. Emmet County Airport at Pellston, Mich., is designated a stop on PCA's route to Sault Ste. Marie. In first six months of '41 PCA sets new, all-time company record for passenger traffic, carrying 133,019 revenue passengers and operating 25,167,331 revenue passenger miles. This represents an increase of 51.38 percent over the first half of '40. For the fourth consecutive month, the all-time revenue passenger traffic record was broken in July when the company carried 36,926 revenue passengers and operated 7,151,809 revenue passenger miles.

TWA files application with CAB for permission to include Lancaster, Penna., as intermediate stop. Company reveals that in June it carried 87 percent more express poundage than a year ago.

Braniff Airways is displaying prominent V's for Victory on all its B-Liners flying the airline's Chicago-Texas-Mexico route.

AIR TRANSPORT INDICATOR

August 1, 1941

132.00

Which is the ratio of passenger-miles reported by the Air Transport Association for all domestic lines for July, 1941, to the figure for July, 1940. Total for the indicator has risen slightly from the previous month. For the first seven months of 1941 traffic stood at 707,155,349, revenue passenger miles — up 23.5 percent over July, 1941. See Finance page for individual companies' traffic figures.

TANNEWITZ DI-SAWS

Do in MINUTES jobs which otherwise require HOURS!

Conservatively estimated TANNEWITZ DI-SAWS save an average of 70% of the time and cost involved in making inside and outside cuts on dies, shoes, templates and hundreds of other operations, including filing and polishing, to which these machines are ideally adaptable. In many instances they are turning out work in as little as ONE-TENTH of the former time required.

To expedite production and cut costs, by all means investigate the tremendous possibilities these machines offer in tool and die making and other applications.

The popularity of DI-SAWING is growing by leaps and bounds. Get the complete facts on the most highly developed DI-SAW on the market. Simply write for our DI-SAW Bulletin.

Made by Sawing Machinery Specialists

SAWING SPEEDS PER MINUTE					
THICKNESS	CAST IRON	COLD ROLLED	TOOL STEEL	HI SPEED STEEL	HI CHROME HI CARBON
¼"	16"	9"	5"	2⅜"	1½"
½"	8"	4½"	2½"	1⅛"	¾"
1"	3½"	2¼"	1¼"	½"	⅜"
1½"	2"	1"	⅝"	5/16	3/16"
3"	1"	½"	5/16"	5/32"	3/32"
6"	½"	¼"	5/32"	5/64"	1/32"

THE TANNEWITZ WORKS, GRAND RAPIDS, MICH.

Dramatic discovery of the Bismarck by a Consolidated Catalina flying boat. The "incident" which marked a turning point in the battle of the Atlantic.
From an authentic report in the London Illustrated News.
CONSOLIDATED
Aircraft CORPORATION
ESTABLISHED 1923
SAN DIEGO, CALIFORNIA
CONSOLIDATED AIRCRAFT
LET'S GO! U.S.A.
KEEP 'EM FLYING!

Lockheed Aircraft shipments total over $11,000,000 a month currently. Deliveries for the first six months of 1941, at $56.9 million, were more than double the $44.9 million volume reported for all of 1940. Practically all the major aircraft companies joined Lockheed in shipping approximately as many planes in the first half of 1941 as they did in all of 1940. Vega, big Lockheed subsidiary with a 112 million dollar backlog, should contribute substantially to the parent company earnings in 1942 when peak operations are experienced.

Sperry Corp. declared a $1 semi-annual dividend in August, similar to the payment made last December. Unfilled orders, largely aircraft and Navy, are in the vicinity of $250,000,000 up $100,000,000 in the past few weeks. Shipments this year are expected to pass the 100 million dollar mark.

Eastern Air Lines reported the biggest second quarter earnings in the company's history. Most other airlines, while showing large gains in passenger travel (40 percent in the case of American Airlines) showed a disappointing decline in profits for the first half of 1941. Record travel volume in the current quarter may permit some of the lines to forge ahead but the increased costs of training new personnel and the necessity of cancelling trips due to lack of equipment will prove a damper on earning power all this year.

Piper Aircraft sold 2,400 planes in the first eight months of its fiscal year which ends Sept. 30, as compared with 1,240 in the like 1940 period. In dollar sales that amounts to nearly $3,200,000, as against $1,560,000 a year ago.

Switlik Parachute received $3,400,000 in new orders during the first six months of 1941, bringing the present backlog up to in excess of $4,000,000. Orders are for such items as parachutes, safety belts, clothing and helmets. Trenton, N. J. plant is running at full capacity with over 400 employees.

National Aviation Corp., an aviation investment trust, has disposed of its airport properties at Washington, D. C., according to President Frank Russell. The Washington-Hoover airport was sold to the federal government for $1,000,000 while 1,000 acres at Hybia, Virginia were sold for $60,000 to the government.

Harvill Aircraft stock sale has been completed through the distribution of 27,000 common shares at $3.55 a share by a group of bankers. The stock represented part of the holdings of Blair & Co. which originally totaled around 75,000 shares.

Glenn L. Martin starts operations in two new plants this fall at Baltimore and will have the Omaha sub-assembly plant ready early in the winter. Company recently borrowed an additional $4,000,000 from a New York bank which has agreed to take promissory notes from the Martin concern up to $28,000,000. The loans to date total $7,000,000.

Fairchild Aviation will show increased earnings this year and in 1942, according to James F. Ogsbury, president. Mr. Ogsbury recently stated that "the year 1941 should end with a substantial increase in earnings over the $1.92 per share earned in 1940 with a further expectation that the results in 1942 should also be very satisfactory due to the large amount of unfilled orders carried over."

By Raymond Hoadley

Now that most of the first-half earnings reports are in, profits of the aircraft manufacturing companies thus far in 1941 may best be described as extremely "spotty". Increased taxes and wages have taken their toll as we had feared they would and a number of the major companies such as United Aircraft Corp. and Glenn L. Martin Co. reported fairly sharp declines in net for the period under review despite the fact that sales deliveries for the first six months this year were almost as large as in the full twelve months of 1940. On the other hand the accessory concerns (Bendix, Fairchild Aviation Corp., Eaton Mfg. Co., etc.) in nearly all cases experienced a gain in earning power. Boeing, Consolidated and North American Aviation will each enjoy excellent year's earnings if current operations keep pace with the results shown for the earlier months. The airlines generally are running under 1940 profitwise although T.W.A. surprised Wall Street by producing a small profit in the June quarter, one of the few times this company has been in black ink in recent years. While shipments will be larger in the September quarter, this period also will be the first to shoulder the full brunt of recent wage increases for several aviation companies. Thus profits for many may not show an appreciable gain over preceding months.

Industry Backlog

Unfilled defense orders of the aircraft makers now total upwards of seven-billion-dollars, an increase of approximately one-billion dollars in the past month. As the defense program calls for an airplane output of $11,469,000,000 probabilities are that the backlog of orders will soar close to ten billion dollars before sales deliveries exceed incoming business. The automotive industry alone has $1,500,000,000 in aircraft orders—an amount twice the backlog of all the aviation companies at the close of 1939. A year ago unfilled plane orders stood at slightly more than two billion dollars; six months ago they were $3,875,000,000. Approximately 65,000 airplanes are on order for delivery to the Army, Navy, the British, China and the Dutch East Indies. Already backlogs of several major companies are large enough to keep plants operating at capacity for the next eighteen months. Defense plane deliveries in the first half of 1941 topped those for all of 1940. Even so, shipments for the twelve months ended June 30 amounted to only 12,000 planes and it appears likely that the government may have to revise downward its goal of 2,700 planes a month by December, 1941.

The following table gives the latest approximate backlogs of the defense aircraft producers:

Aviation Corp.	$16,000,000
Beech	90,000,000
Bell	80,000,000
Boeing	290,000,000
Brewster	95,000,000
Cessna	20,000,000
Consolidated	750,000,000
Continental Motors	35,000,000
Curtiss-Wright	925,000,000
Douglas	580,000,000
Fairchild	18,000,000
Ford	737,000,000
General Motors	448,575,000
Grumman	65,000,000
Lockheed	295,000,000
Martin	640,000,000
Nash	45,000,000
North American	390,000,000
Northrop	45,000,000
Packard	167,000,000
Republic	67,000,000
Ryan	15,000,000
Studebaker	100,000,000
United Aircraft	450,000,000
Vega	112,000,000
Vultee	165,000,000
All others (Venders)	500,000,000
	$7,140,575,000

Current Earnings Reports

Company	Period	Net Profits 1941	Net Profits 1940	Profits per share 1941	Profits per share 1940	Sales 1941	Sales 1940
Aero Supply	6 mos. June 30	$281,710	$281,142	$0.66	$0.66	$3,368,000	$1,567,895
American Airlines	6 mos. June 30	866,717	887,405	1.32	2.48	11,603,452	9,231,303
Bell Aircraft	6 mos. June 30	263,000	.....	1.05	.....	4,200,000	.....
Bendix Aviation	9 mos. June 30	3,603,033	2,361,539	1.71	1.13	.....	.....
Boeing Airplane	12 mos. June 30	2,405,961	.....	2.22	.....	.....	.....
Consolidated	6 mos. June 30	.....	.....	4.72	.....	35,930,488	9,349,550
Continental Motors	6 mos. April 30	1,224,129	.....	0.41	.....	.....	.....
Eastern Air Lines	6 mos. June 30	768,662	733,926	1.34	1.32	6,882,505	5,415,616
Eaton Mfg.	6 mos. June 30	1,979,764	1,908,348	2.81	2.71	.....	.....
Ex-Cell-O	6 mos. June 30	1,088,707	829,884	2.73	2.09	.....	.....
Fairchild Av.	6 mos. June 30	365,049	318,946	1.08	0.95	.....	.....
G. L. Martin	6 mos. June 30	2,950,640	4,291,490	2.69	3.92	27,383,291	.....
No. American Av.	6 mos. June 30	3,900,745	2,367,638	1.13	0.69	36,682,650	14,578,317
Parker Appliance	12 mos. June 30	1,257,209	617,768	3.79	.....	7,937,787	3,101,196
Republic Av.	6 mos. June 30	D 318,940	842,161	.....	0.75	.....	.....
Square D Co.	6 mos. June 30	1,397,346	905,130	3.19	2.03	19,349,365	11,673,820
Thompson Products	6 mos. June 30	923,199	1,047,902	2.89	3.31	6,004,306	4,899,055
T.W.A.	6 mos. June 30	D 756,166	D 72,002	.....	.....	21,830,167	39,217,884
United Aircraft	6 mos. June 30	5,583,350	6,228,106	2.10	2.34	.....	.....
Vultee	6 mos. May 31	D 593,488	D 335,318	.....	.....	.....	.....
Waco	6 mos. Mar. 31	248,835	.....	1.71	.....	.....	.....

D — deficit.

Bell Aircraft will make a public stock offering of 100,000 common shares. Proceeds from the sale will be used for working capital and G.M.P. Murphy & Co. will head the underwriters. Based on deliveries since July 1, it is estimated the company's shipments for the last six months of this year will exceed $25,000,000.

The airlines are benefiting from a heavy flow of defense materials as well as passengers flying on defense business. Bulk of the defense materials shipments consists of machine tools and aircraft parts, optical and medical instruments.

Here And There . . . *American Airlines* may lose $1,336,375 in air mail pay received during the last eighteen months if the new mail rates recommended by a Civil Aeronautics Board examiner are adopted and are made retroactive . . . *Nash-Kelvinator* may receive a big engine parts subcontract which would boost output of one of the major aircraft engine makers by 25 percent . . . Backlog of *Bendix Aviation* is now in the neighborhood of $300,000,000, despite increasing deliveries . . . J. G. Boardman has been elected a director of *Brewster Aeronautical* . . . *United Air Lines* has been exonerated of charges of collusion in obtaining air mail contracts back in the Hoover administration but no decision has been made on its claim of $2,844,000 against the government . . . Kollsman Instrument division of *Square D* has started an expansion program which will nearly double production capacity by next March . . . *Continental Motors* is said to be nearing the production stage on a new aircraft engine of its own design . . . *Consolidated Aircraft* shipments in June were larger than the 1940 total deliveries . . . *United Aircraft* operating costs in the second quarter increased to $54,597,000 from $17,786,000 a year ago.

Aircraft industry officials estimate that profits on aircraft sales in 1940 amounted to 11.2 percent, compared with 9.3 percent in 1939. Sales of planes, engines and propellers in 1940 totaled $554,440,000, as against $224,000,000 in 1939.

American aircraft factories will buy $840,000,000 of parts and supplies or approximately $70,000,000 a month for the next year, according to a survey made by the Aeronautical Chamber of Commerce. The nation's total aircraft parts business amounted to $222,234,000 in 1940.

Material Shortages

Now that the War Department has revised its specifications to permit the increased use of scrap aluminum in defense work, it is estimated by O.P.M. officials that the suply of aluminum for the balance of 1941 will just about equal the aircraft and other armament demand. August production of virgin aluminum totaled around 57,000,000 pounds, as against defense needs of better than 60,000,000 pounds. Defense requirements for the white metal in the last half of 1941 will come to about 344,000,000 pounds; 17,000,000 pounds more than the virgin aluminum producers can supply in that period. Secondary metal will be used to make up the deficiency.

While we will just about get by on aluminum for defense over the rest of the year, the situation in magnesium (second of the two defense metals that particularly affect the aircraft industry) is not so satisfactory. England did not take her full lease-lend allotments during the summer, enabling the O.P.M. to take care of nearly all defense needs for magnesium in July and August. However, Great Britain again is in the market for large quantities this fall to use in the making of incendiary bombs and there won't be enough left here to go 'round. The result will be that aluminum will have to be substituted for its lighter companion metal, magnesium, in many instances, including perhaps, undercarriages and landing gear on aircraft.

Solar Aircraft has an application with defense officials for a $500,000 plant expansion at San Diego and in addition is negotiating manufacturing facilities either in the middle west or on the Atlantic coast. Besides the common stock financing of several months ago, Solar has established credit lines at the banks for working capital purposes.

Money for Blimps

Twenty-seven additional patrol blimps are authorized to the Navy. Funds are now provided for 21; six being already provided for. These ships cost $325,000 each; capacity 415,000 cu. ft. Other funds are being voted for three new bases, at Norfolk-Hatteras, Boston, and San Francisco. The patrol blimps will base at these new points, and also at Lakehurst and Cape May. The only bid thus far received on the new ships is from Goodyear. Navy is trying to interest one other company. Goodyear has already built a number of them. Neither blimps nor dirigibles could be used in modern combat as they were in the World War. Dr. Hugo Eckener told Congress some time ago they would be destroyed instantly by planes and guns. They are good only for patrol far from the enemy.

Helium Expansion

President Roosevelt has asked for a supplemental Interior Department Appropriation of $1,578,500, mainly for construction of helium plants designed to fill immediate needs of Army and Navy lighter-than-air craft.

Of the total appropriation, $1,250,000 would be devoted to construction of new helium plants and enlargement of existing facilities. The request was accompanied by a letter from Budget Director Smith, explaining that further helium-producing facilities were needed to augment production at the Amarillo, Texas, plant.

Silk Story

This is how the defense silk story adds up. To hamstring Japan, President Roosevelt froze their exchange with this country, which means no more silk. Japan supplies 85 percent of all we get. But Army and Navy is not seriously concerned. Both have considerable reserve stocks. And to that probably will be added practically all supplies now in the U. S. OPM promptly stopped all use of silk for civil goods, which means the Government can buy it. But if silk does run out, Army and Navy can make parachutes out of cotton, rayon, or nylon, which are plenty good.

Hydrogen Sausages

Paris, Tennessee, has been selected as the site for a new Barrage Balloon Training Center. Construction will commence as soon as plans can be made and contracts awarded, on facilities for 7,000 men.

Training with the hydrogen-filled sausages is now underway at the temporary Barrage Balloon Center at Camp Davis, N. C. The school at Camp Davis was opened formally Monday, July 28. Instruction at Paris will be given to 160 officers and 750 enlisted men, attending six and twelve-weeks' courses. Hydrogen is used because it has more lift than helium, and there is little danger of fire.

Since May, the Coast Artillery Corps, in command of many other weapons for ground defense against aircraft, has had the responsibility of developing barrage balloon defenses, but the Air Corps retains responsibility for the development and procurement of balloon equipment.

Floating at great heights the barrage balloons are anchored to 2½-ton trucks equipped with winches to raise and lower them.

Barrage balloons, with their dangling cables, put the fear of entanglement into dive bombers.

For Army training, a barrage balloon is 35 feet in diameter and 87 feet long. The outer covering is of cotton fabric, impregnated with synthetic rubber.

Two types of barrage balloons are under experimentation—one called a balloonet, and the other dilatable. In the balloonet type the lower portion of the balloon is a separate air chamber, which takes the wind in a scoop, which helps stabilization. In the dilatable type, rubber shock absorber cords permit the balloon to expand or contract as pressure is changed.

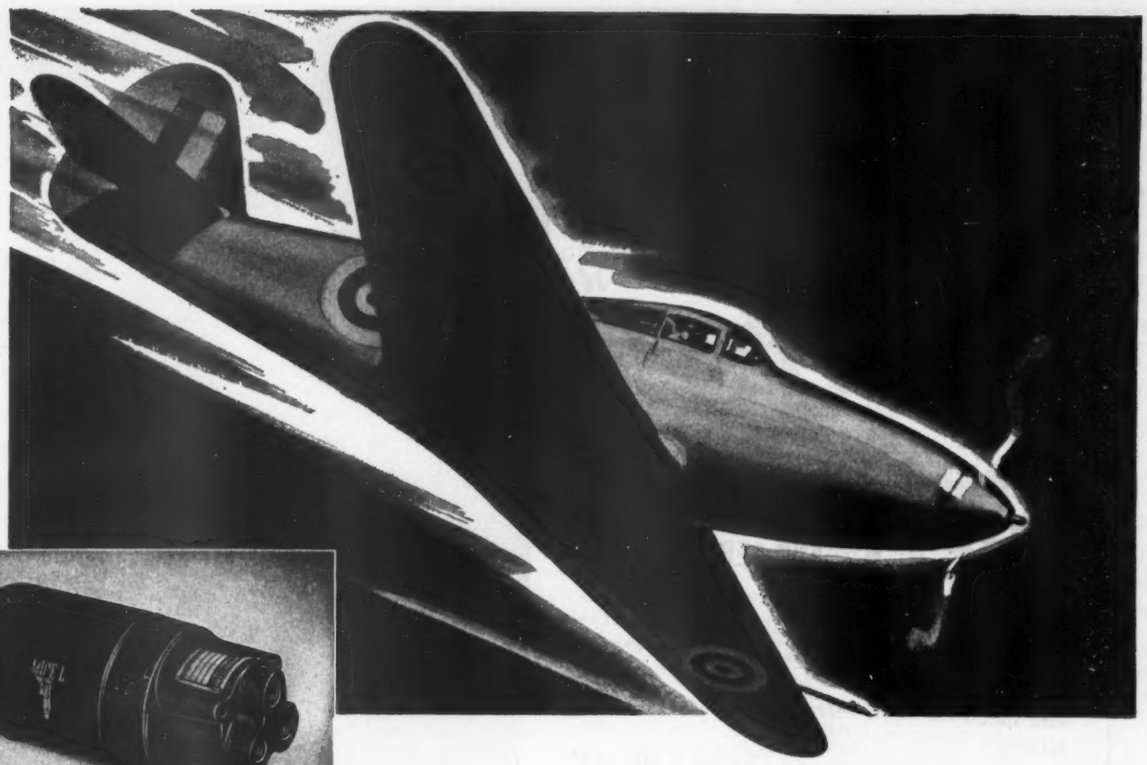
Squadron of Giros

The Army is getting 13 Pitcairn-Larsen Autogiros, upon request of the chief of Field Artillery, for test as "flying observation posts" from which to observe artillery fire, lines of progress in attack, disposition of troops. Tests will be made in cooperation with infantry, cavalry, and the armored forces. This giro has a pusher propeller, for 100 percent visibility, and jump takeoff. Army says this is the first giro rugged enough to stand military operation. Communication with the ground will be by two-way radio, and by frequent landings. Giros will fly low over friendly troops.

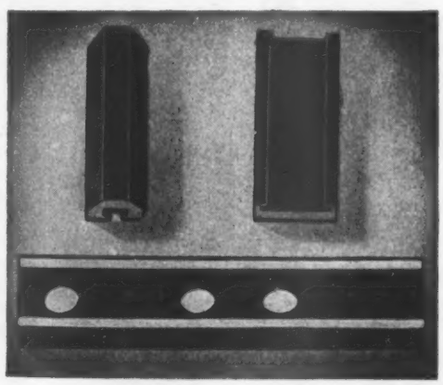
16 Latin Pilots Train With AAF

Sixteen qualified Army pilots from 8 Latin American republics began a three-month refresher course with the U.S. Army Air Corps Flying School at Randolph Field, August 23, the War Department says.

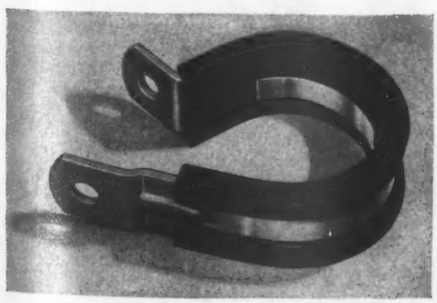
The aviators are part of a group of 65 junior officers serving in various branches of the U.S. Army for six months. After graduation from this special course they will spend 2½ months with Air Corps, some with pursuit wings, some with bomber groups, and other commands.



Adel Series "J" Anti-Icing Pump—the proven ANSWER based on four seasons of actual service conditions. For propellers, windshields, carburetors.



ADEL Lines Support Blocks, available in over 1500 standardized types to support from 1 to 36 lines. Top—"Adelite" synthetic rubber.



ADEL Line Support Clips, the ONLY clips with Universal Approval of U. S. Army Air Corps, U. S. Navy and Commercial Air Lines.

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A Vultee "Vanguard" Shrieks Down

"On the nose"

ENGINE ROARING ON
SHELL AVIATION GASOLINE
AND AEROSHELL OIL

THREE MILES UP the pilot "peels off." The enemy looms in his telescopic sight. Down, down, down he dives, "on the nose". . . man and metal tense and straining. It's no time for failure!

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VULTEE "VANGUARD" P-48—Vultee fuels this new "Vanguard," the secret "Vengeance" Dive Bomber and all of its other ships with Shell Aviation Gasoline—and lubricates them with AeroShell Oil.

Lima Air Show

An air show will be held in Lima, Ohio, Sept. 7, sponsored by the aviation committee of the Association of Commerce. All of the proceeds will be used for the maintenance and improvement of the Lima municipal airport.

The committee, headed by James A. Howenstine, 1603 W. Market St., is anxious to get in touch with any acts or attractions which might be available on this date.

Expansion Hits Minneapolis

Due to the threat of serious congestion arising from a greatly increased student pilot activity, both private and governmental, the Minneapolis Municipal Airport, operated by the city Park Board, is undergoing an elaborate expansion and improvement program. The administration building was more than doubled in size recently and now represents an investment of $175,000. Concrete runways are being lengthened and widened, and new grading operations are under way, while more than 200 acres of additional land may be acquired.

A modern $90,000 hangar and office building has been constructed to handle the field operations of one airline, and a shop headquarters hangar, costing $175,000 when fully equipped, is being erected for another major airline. And, in line with national defense activities, the Naval Reserve base located on the field will soon be greatly enlarged. It is expected that the improved facilities will bring new Navy activity.

Dawn Patrol Ass'n.

J. Gilbert Leigh of Little Rock was elected president of the Dawn Patrol Association, an organization of Arkansas pilots and aviation enthusiasts, when the group's monthly "dawn patrol" flight converged on Hot Springs in July.

Ernest Bailey, mayor of Cabot, was elected vice-president and John Connelly, CAA coordinator at Hot Springs, was named secretary.

The "dawn patrol" was launched in March by CAA Inspector Bill Barry of Little Rock to increase interest in aviation among the flying and non-flying public. Planes from all sections of the state gather once each month at an Arkansas airport, the host port being determined by a drawing among the participating pilots and passengers the preceding month. Large crowds have turned out at the various airports visited on each occasion.

Leaving their home ports as early as 6 a.m., the fliers arrive at the host port between 8 and 9 a.m., hold a breakfast meeting and then return home.

Fifty-two planes from 18 Arkansas cities and Memphis, Tenn., participated in the July flight. The Hot Springs Junior Chamber of Commerce, of which Connelly is president, was host at the breakfast. Little Rock was chosen as the destination for the next flight, on Sunday, August 3.

Pilots in the July flight included six women: Virginia Strickland and Virginia Rayburn of Little Rock, Lucille Brown of El Dorado, Johnie McCulloch of Magnolia, Emmie Lou Waldon and Dorothy Wilson of Jonesboro.

Schlossbach Field

At a special meeting of the Jersey Aero Club held at Asbury Park-Jumping Brook Airport, Neptune, N. J., Kenneth Morris, chairman of special committees, announced that Lt. Commander Isaac Schlossbach, owner of the airport, had consented to a change of name of the airport to Schlossbach Field, Inc; due to confusion of aviators and the general public with airports of a similar name.

The newly named Schlossbach Field was organized August 1, 1938, and is the headquarters of the Jersey Aero Club, one of the largest private flying clubs in America. The airport was perated by Commander Schlossbach and Verne E. Treat, who last year was called back into the Army Flying Service and who is now an instructor at the Spartan Aeronautical College in Tulsa, Oklahoma. The airport is now under the supervision of Commander Schlossbach who has recently returned from the Byrd Antarctic Expedition to the South Pole.

Extensive repairs to the airport have been made and the field was officially dedicated in honor of Commander Schlossbach by the Jersey Aero Club, July 31, at which time all persons and organizations who contributed to the development of the airport were invited as guests. Among those invited were Gill Robb Wilson, Director of New Jersey State Aviation; Commanding Officer of the Lakehurst Naval Air Station; Members of the Board of Chosen Freeholders; Commissioner E. Donald Sterner; Senator Hayden Proctor; Assemblymen J. Stanley Herbert and Harold McDermott; Neptune Township Officials and Board of Education.

Officers elected for the ensuing year are Lt. Commander Isaac Schlossbach, President; Miss F. Evelyn Mason, Secretary; William C. Applegate, Treasurer, and Harry R. Schlossbach, manager.

Thunderbird Field, Phoenix, Ariz., although located far from any major population center, has developed rapidly into an important primary flight training center for U. S. Army cadets and embryo Royal Air Force fliers. In addition to privately operated training on Thunderbird Field, the Army is building a $4,700,000 basic training center near Phoenix which will be second only to Randolph Field in size and facilities.

Solberg-Hunterdon Airport

Newest large airport in New Jersey is Solberg-Hunterdon field, built by Thor Solberg who in 1935 made a trans-Atlantic flight to Norway. The field was built by leveling and improving what had been four farms and now contains some 370 acres. Two runways of 3,000 and 4,000 ft. are already finished and a third will be 6,500 ft. long. The airport is not far from Whitehouse, New Jersey.

Concrete and steel for a large hangar were acquired from the Florida Building at the World's Fair. The hangar will accommodate some 20 medium-sized airplanes, and will have repair shops, offices and club rooms. A near-by farmhouse is being converted into living quarters for flight students and visiting pilots. Dedication was on July 20.

CAA Explains Rules For Flying Airways

CAA recently issued explanation for pilots of the amendments to the Civil Air Regulations, adopted recently by CAB which in effect stratified the air and established new procedures for civil fliers making contact flights on the civil airways at altitudes of more than three thousand five hundred feet above ground.

There are no changes for flights below altitudes of 3,500 feet, over either ground or water, nor for flights above 3,500 feet NOT made on civil airways.

The minimum ceiling for contact flying is 1,000 feet. If the ceiling be of broken clouds, a pilot must stay 500 feet below or above it.

Flying above 17,000 feet is restricted to military, navy and some air line flying, and other special flights specifically au-

BRITISH flight students of the R.A.F. learn more than piloting at the Dallas Aviation School. Major Bill Long, extreme right, President of the school, is about to demonstrate some fancy western riding for the boys.

thorized by the Administrator.

To make flights under contact flight rules on the civil airways above 3,500 feet, all airplanes are required to be equipped with two-way radio and the pilot must hold the FCC restricted telephone permit.

The radio receiving equipment must be capable of receiving radio range signals in the 200 to 400 kc. band under normal conditions to a distance of 100 miles, and must be of sufficient quality that voice broadcasts will be received intelligibly. Also, the transmitter must be capable of giving clear voice transmissions on the correct frequency. A battery operated set is permissible and a minimum range of 25 miles—which is the radius of a control zone of intersection—is suggested.

The airplane must be equipped with a sensitive altimeter, compensated for changes of temperature, and capable of being adjusted for changes in barometric pressure.

From now on, if flying inside a traffic control area, it will be necessary for the private flier to file a flight plan with the nearest airway traffic control station before he takes off. If a flight is started outside an airway traffic control area but will eventually enter such an area, it is required that the flight plan be filed by radio prior to entering the area. In a flight plan, a pilot must specify, in addition to the time of the scheduled take off, the altitude at which he will fly, and the estimated arrival time at his destination.

In the event of the failure of the transmitting or receiving equipment the private pilot flying on a civil airway must decend to below three thousand five hundred feet or leave the airway.

On civil airways, *outside* of traffic control areas, when more than 3,500 feet above the ground, the private pilot is required to adopt another air line practice and fly at odd or even thousand foot levels measured from sea level. The requirements are shown on aeronautical charts of the Coast and Geodetic Survey.

A pilot must also keep in touch with the nearest airway or airport radio station in the same manner as required for instrument flights and must give position report when passing over designated radio fixes, make of airplane, license number, altitude, and next station to which he will report. Also, before entering a control zone of intersection, a pilot will be required to give the same information in addition to the time he expects to be over the center of the zone.

Snyder Aircraft Corp. in Major Expansion Move

Snyder Aircraft Corporation, Chicago Municipal Airport, have just made important additions to their service facilities by acquiring a new hangar and refueling station located directly west of their overhaul shop and showrooms. This additional hangar provides extra storage space for planes brought in for service as well as convenient refueling facilities for transient flyers.

With the addition of this newly acquired Operation's Hangar, Snyder Aircraft was given a contract for servicing all CAA airplanes for the Third District.

Of further interest is the announcement that Warner Aircraft Corporation, Detroit, Michigan, has appointed Snyder Aircraft as their authorized sales and service agency in the mid-west. Snyder will carry complete stocks of Warner parts so that Warner customers can have immediate repair, replacement and overhaul service. All Warner engine overhaul and repair service by Snyder mechanics will be done according to factory specifications and will carry a Factory Warranty Guarantee.

Having a licensed Magnaflux Service, Magneto Service, Generator, Control box and Starter service, and a complete instrument service, including Sperry and Pioneer instrument agencies, gives a completeness to Snyder Aircraft Service very seldom found in a single organization.

Ten Fields Named

Official names have been given to ten leased Army Air Corps flying fields and a bombing gunnery range.

The Government-owned range at Tonopah, Nevada, was named "Tonopah Range." The seven fields named for deceased flying officers are as follows: Albany, Georgia (Advanced flying field), Turner Field; Biloxi, Mississippi (Technical training school), Kessler Field; Boise, Idaho (Air Base), Gowen Field; Everett, Washington (Air base, formerly known as Snohomish County Airport), Paine Field; Paso Robles, California (formerly Paso Robles Municipal Airport), Sherwood Field; Selma, Alabama (advanced flying school), Craig Field; Taft, California (basic flying school), Gardner Field.

Locations of the three fields used jointly with civilian agencies and names of which were confirmed officially follow: Orlando, Florida, Orlando Air Base; Pendleton, Oregon, Pendleton Field; Tallahassee, Florida, Dale Mabry Field.

TRAINING

Boeing Grad Honored

John Randle Hart, who graduated from the Boeing School two years ago, received the $500 award of the Air Transport Assn. for the best original research having practical application to meteorology and dispatching. Hart is a meteorologist for Eastern Air Lines and his research was a study of fog conditions in and near Miami.

Successfully concluding an experimental program with a group of High School boys ranging in age from 14 to 18 years, the Briegleb Aircraft Company has graduated all eight boys of the class as Soaring Pilots after a training course conducted at Lucerne Dry Lake, near Lancaster, Calif. All of the eight boys made actual soaring flights in the Briegleb BG-6 utility glider with which the course was conducted.

Major C. C. Moseley reports that the first group of 50 British Royal Air Force pilot trainees to complete their instruction at his Polaris Flight Academy in Glendale, Calif., set an amazing record when 100 percent of the boys soloed without a single "wash out." Evidently the urgency of the war crisis helps to sharpen the wits and nerves of the pilot prospects.

Ryan School of Aeronautics is enlarging its Hemet School by 50 percent, although the school has been operating less than a year.

Instrument Course

The popularity of courses at the Chicago School of Aircraft Instruments, an organization which started only last year, is an indication of the need for trained instrument mechanics in the aviation industry. Instrument work is one of those specialities for which only a relatively few men are being trained, yet there is a great shortage of thoroughly trained men both in the field of instrument installation in the factories, and instrument overhaul in airline shops and in military maintenance bases.

The head of the Chicago school is Dan Tilden, who for many years was in charge of the large instrument shop of American Airlines. He knows his work thoroughly and is familiar with all the late-type instruments.

Two courses are now open to applicants. One is a six months day course, and the other is an 18 months evening course, covering the same amount of work. Each course includes a total of 1040 hours. The school is a division of Snyder Aircraft Corp., and is on the Municipal Airport, Chicago.

The Academy of Aeronautics, LaGuardia Field, Jackson Heights, New York, N. Y., now has in complete operation a fully equipped hangar at the westerly end of the field.

This hangar is the only one at LaGuardia Field not in use by some great airline system, the only exception being the Civil Aeronautics Authority.

The Academy's hangar of over 6,000 feet of floor space, is equipped with the necessary tools and power machinery for the maintenance of aircraft and possesses complete servicing facilities.

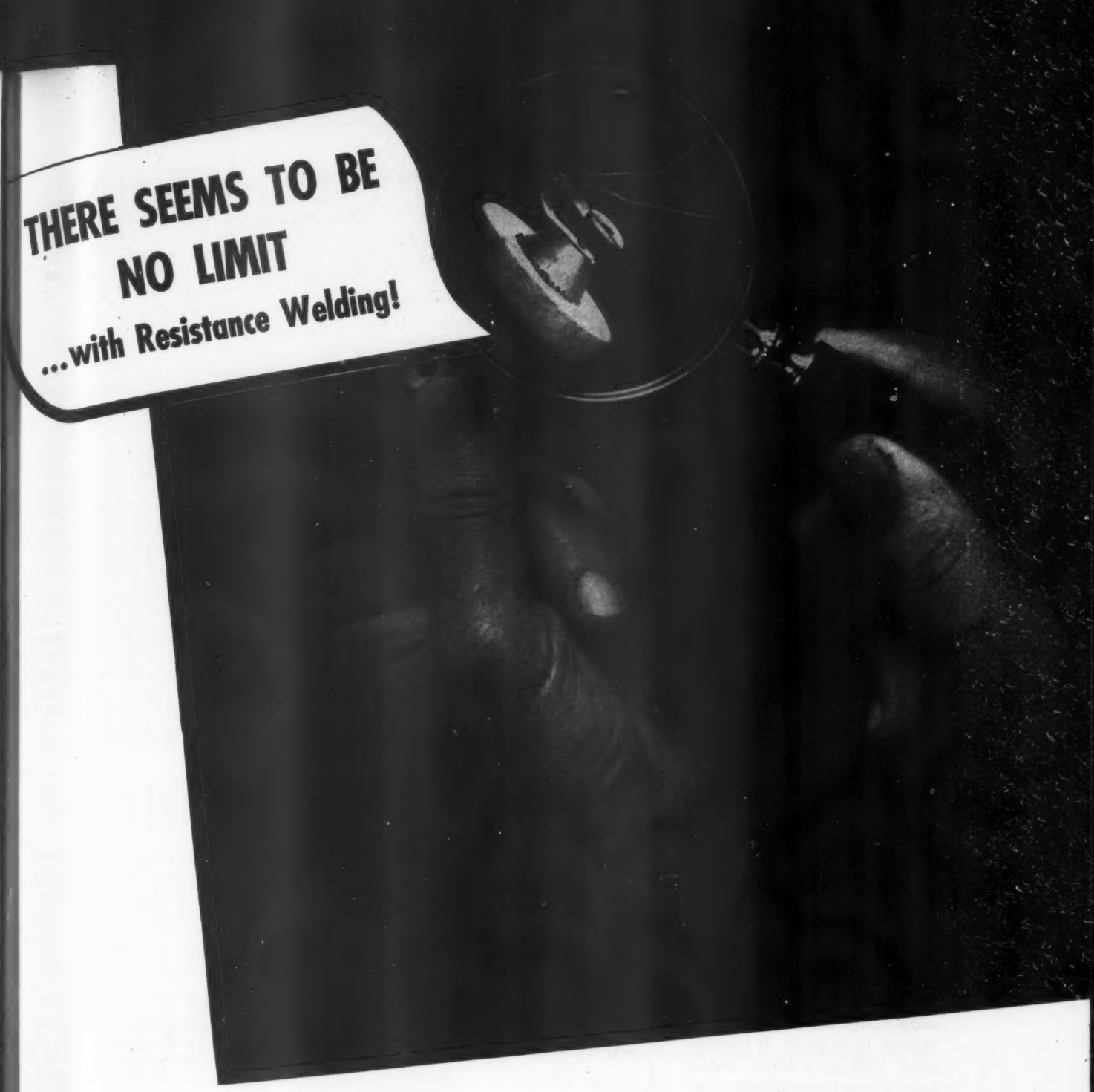
Aircraft Structures Conference

A Conference on aircraft structures will be held at New York University in N. Y. City on September 5 and 6. It is sponsored by the Civil Engineering Div. of the Society for the Promotion of Engineering Education.

Wiggins School

E. W. Wiggins Airways, large fixed base operator, announces that its training division is being developed and expanded into a fullfledged training school for ground technicians. Now known as the Wiggins School of Aviation, courses will be offered to teach airplane and engine mechanics, welding and instrument work. Much new equipment has been purchased. The school is at Norwood, Mass., where the company's overhaul base is located. The firm has over 100 airplanes in all. Both day and evening courses are given.

As the firm's planes are in constant operation, and are subject to rough handling by flight students, the young men receiving mechanical instruction are able to observe and practice latest maintenance methods by practice experience.



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Recent Books

INTRODUCTION TO METEOROLOGY, *by Sverre Petterssen,* 236 pages, $2.50. Published by the McGraw-Hill Book Co., New York.

The author is Professor of Meteorology at M.I.T. and an outstanding authority in his field. His new book was written for the student who is starting his work in weather forecasting, and was prepared to meet the demand for a non-technical text in short and elementary courses in meteorology.

Consisting of 15 chapters, the text covers such basic subjects as the atmosphere, observations and instruments, evaporation, condensation, precipitation, adiabatic temperature changes, stability and instability, temperature variations and their relation to weather phenomena, wind systems, air masses, fronts, cyclones, weather analysis, weather forecasts and weather maps.

OUTLINE OF AIR TRANSPORT PRACTICE, *by A. E. Blomquist.* 402 pages, $4.50. Published by Pitman, New York.

If a great number of new airlines start up soon it will probably be due to this book. Previously the inside workings of airlines has been a deep secret. Now everything is told, and almost anyone could run a line by following the procedure outlined in this new book. The author is an engineer working for Eastern Air Lines. He has written a clear, interesting book which is the first of its kind. Following a brief history of U.S. airlines, he discusses airline management and subsequently each division of airline work. This is distinctly a valuable book for anyone wanting to learn more about airline practice.

FIT TO FLY, *by Lt. Col. Malcolm C. Grow, M.D., and Capt. Harry G. Armstrong, M.D.* Published by D. Appleton-Century Co., New York, N. Y. 387 pages, $2.50.

This book is written for three different groups in aviation; those planning to fly, those beginning to fly and those who are veteran pilots. If you plan to fly in commercial aviation or in the armed services, this book tells you exactly what physical standards you will have to meet and what examinations you must pass before you can be qualified. If you are beginning to fly, you are given detailed descriptions of the physical examinations you will be subjected to at six month intervals and the physical standards you must maintain. And if you are a veteran flier, this book shows you what effects continued flying has on your physical and emotional conditions and how you can offset them.

Written by two medical officers who are eminently qualified to write on their subject, as attested by the foreword by Maj.-Gen. Arnold, all fliers, potential and veteran, should find "Fit to Fly" of particular value to them.

STRENGTH OF MATERIALS, *by S. Timoshenko.* Part II, Advanced Theory and Problems. 510 pages, $4.50. Published by D. Van Nostrand, New York.

This book was first published in 1930, and has now been revised and brought up to date. The author is Professor of Theoretical and Engineering Mechanics at Stanford University. The new edition contains considerably more material than the well-known earlier edition.

Chapters in the new book are on the following subjects: special problems on the bending of beams; curved bars; thin plates and shells; buckling of bars, plates and shells; deformations symetrical about axis; torsion; stress concentration; deformations beyond elastic limit; mechanical properties of materials.

THE ENGINEERING INDEX, 1940. $50. Engineering Index, Inc., 29 W. 39th St., New York N. Y.

The 56th Volume of the Engineering Index is an impressive title, and serves to indicate that a service that has stood the test of over half-a-century has proved its merits. Here you have some 26,000 annotations of important articles on all branches of engineering that have appeared in domestic and foreign current technical periodicals, 40,000 cross-references to these annotations, and an authors' and contributors' list of approximately 19,000 names. Undoubtedly a useful volume and a valuable piece of equipment for the engineer. Purchase can be made on a deferred payment plan.

AIR PILOTING—A MANUAL OF FLIGHT INSTRUCTION, *by Virgil Simmons.* 738 pages, $4. Published by the Ronald Press, New York.

The first edition of this book sold so well that the author has rewritten it. The author is well qualified to write a text, as he has served as flight instructor in both the army and navy, as well as at the Boeing School. He is now Director of Training, Civil Flight School, Spartan School of Aeronautics.

There is not space to do justice to this large book. It contains 18 chapters plus an appendix, and is what we would call a really comprehensive book.

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EVERY true American is eager to serve in defense of our country . . . but today's defense takes more than willingness. It demands preparation, all the resources of industry . . . and, in back of it all, trained men. In the No. 1 defense industry, Aviation, thousands upon thousands of qualified men are urgently needed, on the ground and in the air.

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Radiolocator

(*Continued from page 95*)

solution of a new and intensely practical problem.

Continuing with the development of our speculation, our theoretical radiolocator consists of a microwave transmitter of special design and a microwave receiver to indicate that the microwaves are being reflected by an object in their path. The method of showing that an enemy plane is within range is to feed the reflected energy, amplified in the receiver, to a cathode-ray tube. This will produce a spot on the cathode-ray tube screen and in itself is not very much. The location of the plane can be determined in the following manner. Borrowing from television, the radiated microwave beam is made to scan a large area of the sky in an orderly manner, similar to the scanning of a television screen. This means that a certain portion of the sky is chosen for examination, the size of which at the moment is not important, but may be of large dimensions such as 10 miles square at a distance of 10 miles from the transmitter. The mocrowave beam is made to sweep across the uppermost limit of this area. As it reaches the end of the sweep it is returned back to the starting edge, but some distance below the first sweep path. It sweeps across the area again, this time slightly below, just enough so that there is no overlapping. The process is repeated until the entire area is scanned when the cycle repeats itself. Scanning of the field under examination is repeated at very short intervals of the order of about 1/30 of a second.

In synchronism with the scanning of the sky, the screen of the cathode-ray tube is also scanned. Thus, for anything in the scanned area of the sky which reflects the mocrowaves, a light spot, or a dark spot depending on the polarization of the circuit, will appear in the corresponding position on the cathode-ray screen. With a system of coordinates the position of the plane in the scanned field can easily be determined. This, however, is not the complete story. To determinate the exact geographical position of the plane and its altitude it is necessary to use two of our hypothetical locator units separated by a considerable distance. The location and altitude are then determined by the triangulation methods of everyday navigation. It is also possible to determine the distance from a single locator to a plane by the method used in the terrain clearance indicator developed several years ago by Bell Laboratories.

Propellers

(*Continued from page 63*)

the Blade, Assembly and Inspection departments along with the materials control, receiving and shipping departments, and the work of procurement started early to assure perfect timing in establishing those departments on production basis. Gage requirements received special study because of slow delivery quoted on precision tools, and needs of the gage crib, inspection department and the process inspection operations in the production departments were analyzed.

First Production

Two hundred and ten days after the lease was signed, the first Hydromatic propeller was produced. Ninety days were consumed in preparing the plant. 120 days elapsed after the first employes were hired and the training program started for the blade department to reach production basis. Now 700 employes have been hired, trained and are working on 3 shifts. Production is exceeding estimates of what could be done with new workers and the 1,000th propeller went out the back door the second week of August—nine months after start of operations.

The original plan of manufacturing operations in the new plant called for utilization of but 125,000 sq. ft. of factory floor space of the 240,000 available. The fourth floor of the four-story building and the two upper floors of the three-story building were left idle against future expansion requirements. The floor space still available would permit 100 percent expansion of assembly schedules. Future expansion even calls for manufacture of certain small parts at the Pawcatuck plant to release precious floor area in East Hartford.

The plant layout has already been revised for all departments, to effect a 50 percent increase in production, and the additional machines and equipment are on order. Some departments such as materials control require but an expansion of floor area to be equipped for the increase, other departments, such as Inspection, need additional equipment—gages, Rockwell and Brinell machines, while the Blade department must have an entire new blower line; additional benches; and flexible shaft polishers—necessitating installation of a new cyclone; and a number of new machines.

Today, Hamilton Standard is abreast of all American and British orders with a single minor exception involving less than 10 planes.

Solving Aviation's No. 1 Assembly Problem

Thor Riveting Hammers

COMBINE HIGHLY SENSITIVE CONTROL, EXTREMELY LIGHT WEIGHT, AND HARD HITTING POWER

TO SPEED UP RIVETING!

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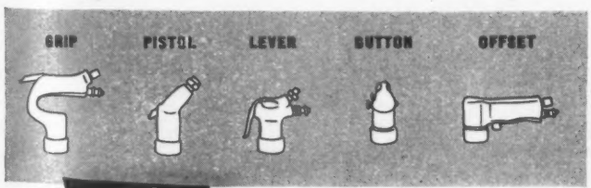

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Sensitive Control. By means of the THOR Throttle Valve Regulator the operator can increase or decrease the amount of air fed to the hammer without loss of graduated throttle valve control. And thus strike but one or two blows when necessary . . . upset rivets without driving them back into the hole . . . and drive heads on rivets without expanding the stem and wrinkling the skin.

Light Weight. Weighing as little as 39 ounces, trim in line, THOR Hammers can be handled easily and accurately on the most delicate operations. Five different handle styles meet varying operating conditions.

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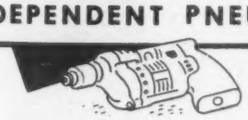

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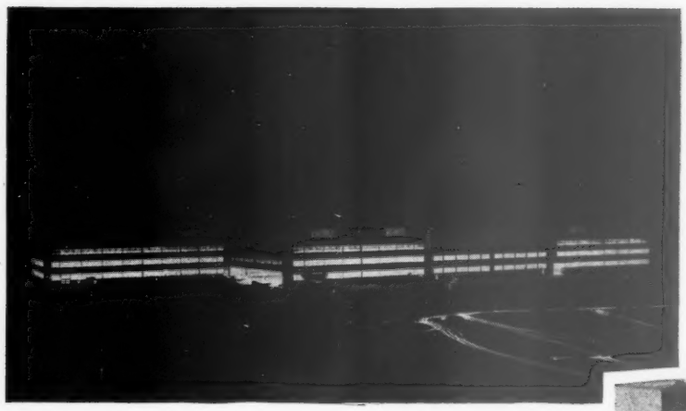
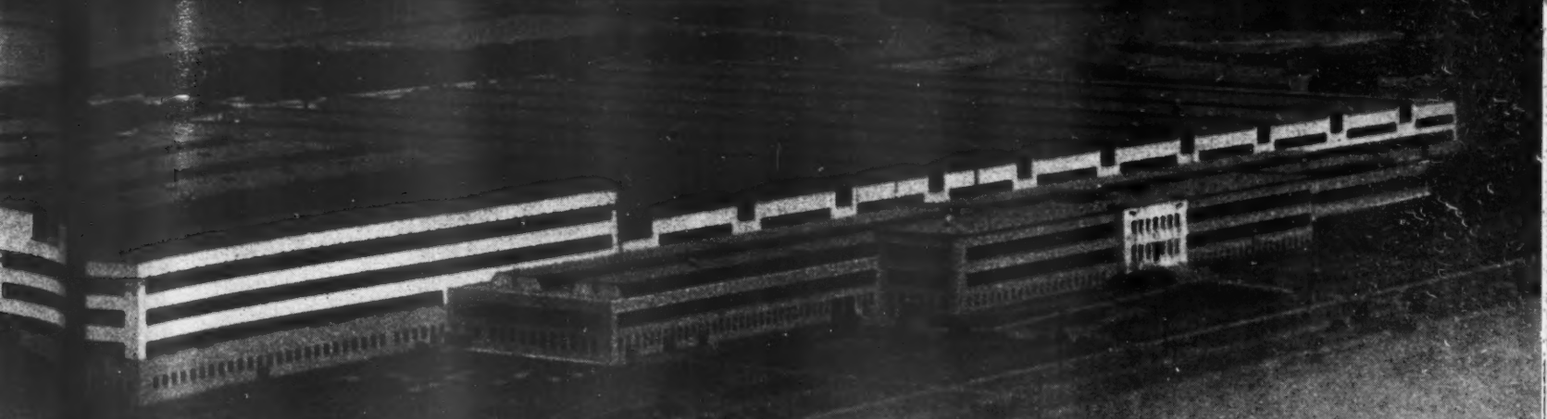


Night view of the new Curtiss Buffalo Airport Plant, which is working 24 hours a day.

(Above) Entrance to 1,500,000 sq. ft. Curtiss Plant. (Below) Curtiss P-40 E's and Kittyhawks on assembly floor.

g the Battle of PRODUCTION



New Curtiss Buffalo Airport Plant Largest Source of Combat Aircraft

ALREADY in mass production, only 9 months after ground breaking, another new Curtiss-Wright factory is working 24 hours a day on the greatest quantity orders for pursuit aircraft ever awarded in this country. Supplementing Curtiss-Wright's present facilities at Buffalo, this mammoth new 1,500,000 sq. ft. plant is helping to win the battle of production for National Defense.

On August 14th the 2,000th pursuit of the U. S. Army Air Corps P-40 type rolled off the production lines. This renowned family of military aircraft includes the Tomahawk and Kittyhawk fighters built for the Royal Air Force.

The new Buffalo plant is one of three of similar design constructed at Buffalo, Columbus and St. Louis. Together these facilities, supplementing the original Curtiss plant at Buffalo, will give Curtiss-Wright's Airplane Division over 5,000,000 sq. ft. of floor area—America's greatest single expansion for the production of fighting aircraft for the defense of our nation.

CURTISS-WRIGHT

CORPORATION

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Selig Altschul

(Continued from page 96)

Closer cooperation between the air lines and other transportation agencies is becoming more pronounced. The latest wrinkle is an all-expense vacation tour utilizing an airline, a railroad and a bus line between St. Louis and New Orleans via Mobile. This triple cooperative effort, known as the "Merry-Go-Round", employs the Gulf, Mobile & Ohio Railroad's streamliner from St. Louis to Mobile, a Greyhound bus from Mobile to New Orleans and a Chicago & Southern air transport plane between New Orleans and St. Louis.

This experience may well illustrate one phase of the country's future transportation pattern. While coordination and cooperative arrangements among the various transportation groups is highly desirable and may prove essential, there need be no necessity for one agency encroaching upon the other's sphere of operation. Recent developments further strengthen this tendency.

An examination of the stock interest of U. S. Freight discloses some interesting aspects. Approximately 49 percent of this company's stock is owned by the Linden Securities Corp. which in turn is indirectly controlled by the New York Central Railroad Company. The stock owned by Linden, however, is placed in trust as directed by the Interstate Commerce Commission.

Air express by its very nature, has a tendency to attract various interests and groups. The Air Transport Association recognized this problem when it formed Air Cargo, Inc. Owned by the four major lines, Air Cargo will presumably attempt to retain for the air carriers complete control over operations in this field. The needs of commerce are such, however, that more than the mere announcement of a new company is required, if the air transport industry expects to remain dominant in this new phase of commercial aviation.

Currently, the air lines are beset by two major problems. In the first place, operations already seriously curtailed, may yet be further restricted. American and TWA have already suspended certain schedules. With Britain demanding more transports and with new requests from China and for Latin America, the plane situation becomes more acute.

Aside from these cancellations, the carriers, for the most part, are being confined to winter flying schedules. Ordinarily, it is usual for the operators to increase the number of daily flights over heavily traveled routes during the excellent weather of the summer period. Definite limitations to gross passenger revenues thus confront the air lines.

In the second place, the examiner's report on American Airlines mail pay case is the cause of considerable unsettlement in the industry. This report was reviewed in detail last month. In the interim, another examiner issued a report on the mail rates to be paid Chicago & Southern Airlines. In this case, however, the report was favorable to the company. United Air Lines has now entered the picture by having its basis of mail compensation slated for review by the CAB. Yet to come is an examiner's report on Eastern Air Lines mail pay rates.

One of these reports may well be used by Civil Aeronautics Board as a test case to clear the atmosphere of confusion now prevailing.

Surprisingly enough, air line equities have shown stubborn resistance in the face of these adverse news developments. There appears to be a reluctance on the part of present investors to sell their holdings. Then, too, the "floating supply" of carrier shares of the major lines is somewhat limited.

American Airlines shows a total of 574,848 shares of common stock outstanding. Of this amount, however, 193,769 or 34 percent is now held in trust by Jesse Jones for Aviation Corp.

About 44 percent or 415,850 shares of Transcontinental & Western Air common stock were last reported as owned by the Hughes Tool Co. for the benefit of Howard Hughes. Hughes has been a consistent purchaser of TWA and no doubt has accounted for this issue selling at a higher price than its position and earnings would ordinarily justify. In the months of May and June, Hughes' purchases accounted for better than 50 percent of the total of 10,000 shares of TWA traded on the New York Stock Exchange.

The largest percentage ownership among the air transports listed on the exchange is held by William Coulter, president of Western Air Lines. SEC reports show Mr. Coulter owning 192,715 shares or 47 percent of the 409,954 shares outstanding. These holdings include a block of 10,000 shares acquired only this May, presumably in a private transaction. Directors, in the aggregate, own a material amount of stock in the company as well thus leaving a small supply available for public participation.

Among the major air lines, Northwest Air Lines has the smallest number of shares issued—only 234,920, reported outstanding. Should the company's application for a New York Route be granted, it proposes to issue additional common stock to finance new equipment acquisitions.

It is well to note that in all cases enumerated, there is relatively a small amount of stock available for public participation. Under present circumstances, it does not take much buying to rally these issues. This has already been demonstrated in recent weeks. As long as these conditions prevail and so long as present holders maintain their reluctance to part with their stock, air line equities may remain oblivious to the present run of unfavorable news reports.

A factor sustaining air line securities is the constant recognition given their long-term secular growth. It is this future expansion which will require new financing of important proportions.

As noted last month, it is because of these future capital requirements that a constructive economic regulatory policy is essential for the continued growth of the air transport industry. Cautious capital is not prone to overlook the myriad uncertainties of government regulations and the threats of dislocation that are the concomitants of confusing reports and decisions. Recent CAB examiner's reports have created this confusion. It remains for the CAB itself to clearly define an official formula making for a sound constructive mail rate base. This will dispel existing uncertainties.

Table I

Market Action
Leading Aircraft Stocks

	Market Highs 1939	1940	*1941	% Change From Previous Peak to 1941 High
Boeing	35	28	19	−46%
Consolidated	33	31	39	+18
Curtiss-Wright	13	11	10	−23
Douglas	88	95	79	−17
Lockheed	33	42	29	−30
Martin	45	48	31	−35
North American	29	27	18	−38
Sperry	52	47	40	−23
United Aircraft	51	53	44	−17

*Up to August 5, 1941.

Barron's Stock Averages

	Aircraft	Air Transport	50 Stocks
August 1, 1941	38.23	20.16	74
July 25, 1941	38.18	21.50	74
July 18, 1941	37.65	19.28	73
July 11, 1941	38.13	19.81	71
August 2, 1940	35.72	26.97	74

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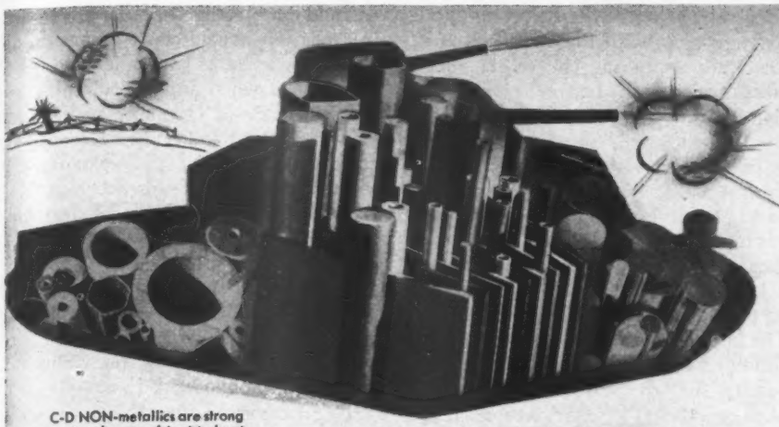

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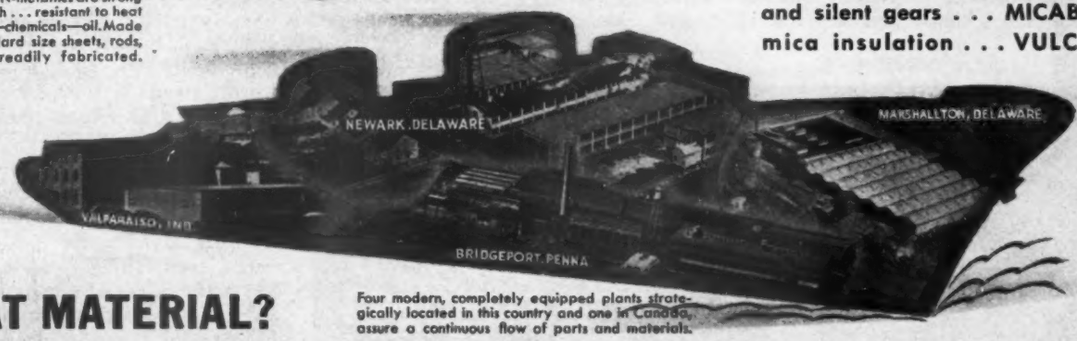

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Japan's Air Power

(*Continued from page 49*)

flying equipment worthy of the name has been available to the Chinese who, nevertheless, have been putting up heroic and at times effective defense, even against air raids. How altered the aerial status over the Asiatic mainland would be if there were anything like a quantitative parity in aircraft may be judged from a recent observation of Ray Scott, war correspondent who went to China four times since Japan's undeclared war began:

"The Chinese would have carried the war to Japan long ago if they had possessed the planes and the bases. They still will do it if the U. S. supplies planes and ammunition. I have watched Japanese and Chinese aviators, and in the air the Chinese are better because they are individualists and more resourceful. The Japanese are imitators."

Japanese imitativeness is not confined to tactical operations but notoriously extends to copying other countries' blueprints of aircraft and aero engines, this circumstance accounting for the obsolescence of their flying machines. For the best and latest designs are guarded secrets and anything released for export to Japan, even by her best friend, the Third Reich, is at least three years old. Hence, Japanese aeronautical engineering lags by at least that much behind the rest of the powers.

When the Japanese finally receive an opportunity to duplicate warplanes from Europe or America, they usually fail to build up to the standards set by the original. An illustration of this is their Type 98 bomber which is patterned, under license, after Italy's Fiat B.R. 20M but, with all its huffing and puffing, does not attain its prototype's 256 m.p.h. at 13,448 ft.

As late as 1939, while fighting on the Manchurian-Outer Mongolian frontier, the Japanese employed Italian warplanes, very likely because they were considered at least equal to their own aircraft. But scarcely more than a year later, the poor quality of the Italian planes was being tellingly brought out in engagements with the British R.A.F.

Generally speaking, there is much aeronautical affinity between Japan and Italy. Both, among the larger nations, bring up the rear in respect to the size of their air establishments. Italy's manufacturing capacity, however, is greater than Japan's; and while the American, British, German and Soviet planes may be superior to the Italian, the latter's quality is strikingly higher than the Japanese.

The peculiar shortcomings of Japanese aviation stem from the inescapable necessity for air power to base itself on heavy industry of enormous capacity, what with immense replacements and reinforcements demanded by modern air services in combat. Economic and military experts unanimously inform us that Japan's current output of military aircraft of all types, including trainers, is about 250 a month, shared about equally by the army and navy.

Mitsubishi Karigane has an 800 hp. Mitsubishi A.14 engine with a reported top speed of 310 m.p.h. This model is used for both commercial and military purposes.

Meagerness of production is conditioned by the fact that Japan always has been among economically weak countries. Deficient in raw materials and supplies, her aviation industries' range has been painfully circumscribed. Among the barriers to realizing her ambition to keep in step with other powers is the absence or dire shortage of such strategically vital materials as iron ore, manganese ore, non-ferrous metals, petroleum, rubber, cotton, wool. A very negligible percentage of her needs in petroleum, tin, aluminum and lead is satisfied domestically. Iron and steel industries cannot meet the wartime demands. At least 20 percent of wartime iron will have to be imported, it is admitted, but no one has yet suggested from what source. Japan cannot produce at home even one third of the steel made annually in either Germany or the Soviet Union.

And so Japan, over a period of years, has grown accustomed to depend for her industrial supplies on the very nations that are her likeliest adversaries in a possible armed clash—America and England—a fatal dependence. There was a time when Japan could also look for assistance to Germany in the event of war in the Pacific. But German aircraft could be sent to Japan only by shipment on the Trans-Siberian Railway or flown over Soviet territory; neither of these channels is now open due to the Nazi-Soviet war.

How dependent Japan's aeronautical industries are on the U. S., for instance, may be gauged by recalling that on the eve of Japanese attack on China five years ago, Tokyo added some $15,000,000 (American) worth of machine tools, imported and locally made. In 1940 the Japanese supply of new machine tools, imported and domestic, was worth about $70,000,000 (American) or less than 10 percent of the American supply.

Now Japan's acquisition of vital machine tools is being severely restricted by comparison with 1940 because the U. S. is hoarding for its own domestic needs, even failing to fill the orders of the nations that she is assisting in the war. This situation cannot be counterbalanced in Japan by domestic production.

Japan's technical inferiority is thus determined by the inadequacy of machine tools, a factor which was frankly admitted by the Military President of the recently formed Japanese Planning Corps.

Even if Japan should miraculously come into possession of a great air force, it would lack the necessary ground support of tanks, field artillery, anti-aircraft guns, all of which are largely imported since the military engineering industries are as weak as the aeronautical. Conversely, the land forces lack support from the air, so indispensable in contemporary warfare. If more evidence is required of the Japanese engineering backwardness, it may be of interest to note that while the leading designers in other parts of the world are introducing in their national air forces 2000 hp. engines, the Japanese are still to produce their first 1000 hp. motor.

Aero industries of Japan, in sharp contrast with the methods elsewhere, make extensive use of small shops and factories, each employing a small number of workers. No wonder the annual maximum output of 3,000 planes does not suffice to maintain the air arms even in peacetime.

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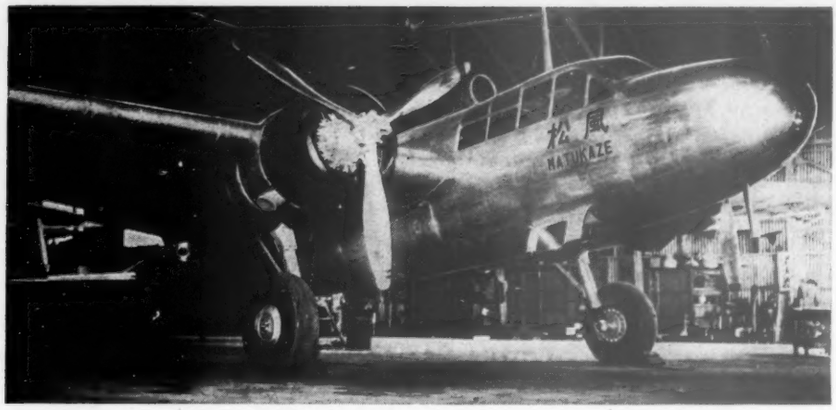

The Matukaze was finished in the summer of 1940 and three such ships inaugurated airline service between Tokyo and Bangkok.

mechanical background and the resultant unavailability of the finished aircraft are responsible for the small numbers of trained flying and ground personnel, previously noted. Training of pilots has been geared to the supply of aircraft, so that even if Japan were suddenly endowed with a large air force, she would not have the crews to man it.

Strikingly small, this air contingent has had little actual fighting experience against a major opponent. With the sole exception of the Manchurian-Mongolian border war, in which Japanese airmen were pitted against those of the Soviet Union and had come off a poor second, they had little opportunity to encounter first-rate enemy fighters. To be sure, they have somewhat perfected their bombing and reconnaissance flight during the Chinese operations, in which no substantial air opposition was offered to raids on comparatively undefended objectives. The Japanese fliers are utterly inexperienced in the mass tactics of air war as it is being fought in Western and Eastern Europe.

Despite technological defects, Japanese air strategy is decidely offensive, an emulation of the German doctrine of totalitarian warfare. Anyone familiar with aircraft losses of the past two years on Europe's Western and Eastern fronts, and even with equipment casualties in Africa, knows what a catastrophe Japan would be courting with her present manufacturing and manpower facilities if she grapples with any first-rate industrial power, let alone a coalition of powers. Numerically meager, obsolescent and qualitatively inferior, the Japanese air weapons would be matched in the Battle of the Pacific against a much stronger combination of adversaries than her formidable Axis partner, Germany, ever had to face in Europe.

Consider what would be perhaps the weakest partner in an anti-Japanese bloc in the Pacific—the Netherlands Indies. There the Dutch strength has been unofficially estimated at 300 to 900 warplanes, mostly Fokkers from the mother country ,and Dorniers earlier acquired from Germany. The proportion of American planes in the Indies air force is growing and Washington has issued licenses for a large volume of additional flying equipment. Instructors released from the U. S. armed services are training the natives. Numerous airdromes and emergency landing fields have been constructed in the interim of more than a year since the collapse of Holland.

Of course, in the event of attack upon them, the Netherlands Indies could not repulse Japan by themselves. They are counting on prompt assistance from both the British and the Americans. How important the possibilities of air war in the Pacific are considered by the British may be judged by the fact that the Commander of *all* their forces in the Far East is an Air Marshal. Some months ago a British spokesman claimed that his country already had mastery of the air over the South China Sea, the great strategic area where the most important engagements are expected to unfold.

At this writing the Dutch-British air power in the Pacific may be 2,000 modern aircraft, more by a third than the modern planes of the Japanese Navy. The British can strike hard from their air bases at Hongkong, North Borneo, Australia. Based at Vladivostok and surrounding territories, the Soviet air contingents are quantitatively, qualitatively and geographically so powerful that Japanese Admiral Nakamura was moved to declare some years ago:

"Many of our great commercial and naval harbors would be open to attack, and the enemy, being well informed as to our resources, would know in what direction to concentrate his efforts. On the Pacific coast, the capital of Tokyo, the huge entrepot of Yokohama, and the naval arsenal of Hokohukka would lie open to the visitations of hostile flying machines. Osaka, the heart of our national industry, would not be beyond an enemy's reach, and the swarming industrial hives of Kuyshu would present him with innumerable targets."

The margin of strength between the USSR and Japan has since then widened. All of Japan's great harbors are today exposed to the attack of the experienced Soviet airmen who have tremendous equipment and manpower reserves to sustain them; nor would the Red operations be confined to air activities.

Obviously, overwhelming concentrations of air power are closing in on Japan which certainly has not been strengthened by more than four years of self-depleting aggression on the mainland, a foreboding drain on the home resources.

Isolated from the Axis fellow-aggressors, who have their hands full with their own adventures, weak in aircraft numbers and quality, and leaning on an equally weak industry, her air force of low offensive strength and highly questionable as a factor in defending her own cities, Japan if engaged in a great air war would crumble like a house of cards, dragging after itself the myth of her military prowess and the carefully cultivated daydream of Pacific hegemony and complete world domination.

Specifications for Japanese Airplanes

Advanced aspirants for enrollment in the Japanese Imperial Army Air Corps use the Tatikawa 95-1 Trainer, a two-seater with a Type 95 engine of 350 hp. Its specifications are: upper span 32 ft. 9.5 in., lower span 29 ft. 6 in., length 26 ft. 3 in., height 11 ft. 6 in., wing area 260.4 sq.ft., wing loading 11.73 lb. per sq.ft., power loading 8.2 lb. per hp., weight empty 2,178 lbs., useful load 1,056 lb., gross weight 3,234 lb.

Construction of Tatikawa 95-1: welded steel tube fuselage with metal sheet covering in front and fabric covering in the rear, tandem open cockpits, dual controls; single-bay biplane, unequal span, fabric-covered two-spar wood structures, upper center section carried above fuselage upon N struts, interplane bracing by pair of N struts and wires, ailerons on upper wing only; tail group, fin and stabilizer are fabric-covered dural structures; divided type landing gear, tail wheel. Standard equipment: oleo and spring shock absorbers, wheel brakes, low-pressure tires, Townend engine cowl. Performance: maximum speed 143 m.p.h., cruising speed 111.8 m.p.h., service ceiling 21,320 ft., rate of climb 984 ft. per min., range 416 mi. Instruments: standard engine and flight equipment.

A basic military trainer is the two-place Tatikawa 95-3. Its construction, standard equipment and instruments are similar to those of 95-1. Specifications—span 32 ft. 9.5 in., length 26 ft. 3 in., height 9 ft. 10 in., wing area 282.1 sq.ft., weight empty 1,364

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Japanese Air Power

(Continued from page 38)

lb., useful load 616 lb., gross weight 1,980 lb., wing loading 7.17 lb. per sq.ft. Performance: maximum speed 105.5 m.p.h., service ceiling 17,385 ft., rate of climb 579 ft. per min.

The Kawanishi Type 94 seaplane carries a crew of two or three, and has a span of 42 ft. 8 in., length of 31 ft. 8 in., height of 14 ft. 4 in. Its landing gear has twin metal floats and it is powered by an Aichi (Lorraine) engine of 300 hp. at 1,800 r.p.m.

The K.F. 1 six-place reconnaissance flying boat designated Navy Type 90-2 is similar to Short Bros. design, being built under a license from the British firm. With a maximum speed of 133.5 m.p.h., it is powered by three Rolls-Royce Buzzards of 825 hp. each at 2,000 r.p.m. Its span is 101 ft. 8 in., length 72 ft. 2 in., empty weight 33,000 lb. Further data are unavailable.

A representative day bomber supplied in large quantities to the Japanese Army Air Corps is the two-place all-metal Type 93, produced by Kawasaki and mounting two Kawasaki (B.M.W.) engines of 600/700 hp. each. Specifications: span 42 ft. 8 in.; length 32 ft. 9.5 in.; height 9 ft. 10 in.; gross weight 6,820 lb. Performance: maximum speed 161.5 m.p.h.; service ceiling 22,960 ft.; rate of climb 820 ft. per min.

Used in great numbers as a fighter and for reconnaissance, the two-seat Karigane is a modification of a commercial ship. Powered by a Mitsubishi A.14 of 800 hp. and incorporating a full compliment of engine, flight and navigation instruments, this fighter has a maximum speed of 310 m.p.h., cruising speed of 200 m.p.h., cruising range of 1,490 mi. Its standard equipment embraces a Hamilton Standard constant-speed propeller, NACA engine cowls, navigation lights, oleo shock absorbers, radio.

Karigane's specifications: Span 39 ft. 4.75 in.; length 27 ft. 11 in.; height 11 ft. 6 in.; wing area 258 sq.ft., power loading 6.3 lb. per hp., wing loading 19.6 lb. per sq.ft.; gross weight 5,060 lb; fuel 820 liter. It has a flush-riveted, metal monocoque fuselage.

With a crew of three or five, a Mitsubishi long-range bomber called Soyokaze cruises at 161.5 m.p.h. and has a cruising endurance of 10 hrs. It mounts two Mitsubishi Kinsei engines of 900 hp. Specifications: Span 82 ft.; length 52 ft. 6 in.; height 12 ft. 1.5 in.; gross weight 11,000 lb.

Another long-range bomber is Nakajima Type 19 whose commercial prototype carriers a crew of two and five passengers. Specifications—Span 72 ft. 2 in.; length 50 ft. 9 in.; height 11 ft. 11 in.; wing area 675 sq.ft.; weight empty 10,450 lb.

Type 19 bomber's two engines are of the Mitsubishi Type IV, 870 hp. each. Standard equipment: three-blade constant-speed propellers, oleo-pneumatic shock absorber, hydraulic brakes, two-way radio. Performance: maximum speed 217 m.p.h., cruising speed 186 m.p.h., cruising range 2,484 mi.

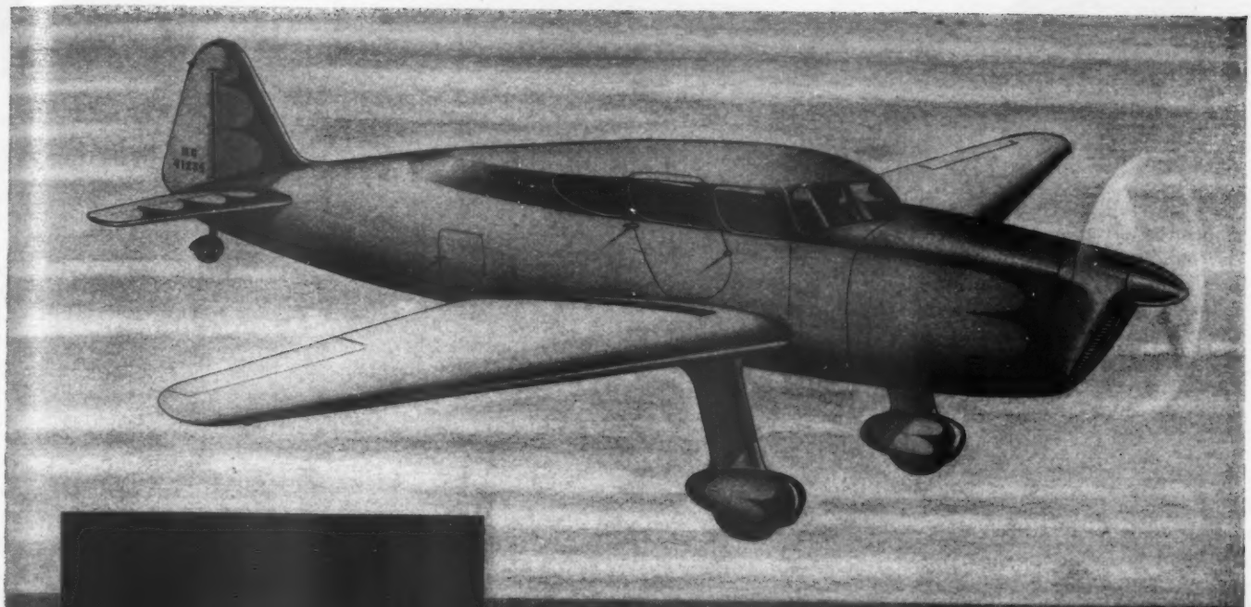
Nakajima Type 94 is a reconnaissance two-seater with a Nakajima III engine of 550 hp. at 1,950 r.p.m., maximum speed of 186 m.p.h., service ceiling of 26,240 ft. and 1,082 ft. per min. rate of climb. The specifications of this single-bay biplane with curved trailing edge: span 36 ft. 7 in.; length 24 ft. 5 in.; height 9 ft. 2 in.; wing area 322.5 sq.ft.; power loading 10.4 lb. per hp., wing loading 16.45 lb. per sq.ft., gross weight 5,720 lb.

Nakajima Type 97 is a one-place fighter with a radial air-cooled engine of unknown make and output. It is a low-wing cantilever monoplane. The wing and fuselage are of metal construction, as well as the tail group. Landing gear features individual cantilever legs.

One of the few Japanese fighters on which armament details are known, Nakajima A.N. 1 single-seater has two fixed machine guns firing through the propeller disc. Other standard equipment includes adjustable-pitch propeller, NACA engine cowl, wheel brakes, oleo and spring shock absorbers, radio. Specifications: span 35 ft. 5 in., length 24 ft. 5 in., height 11 ft., wing area 199.5 sq.ft., empty weight 2,650 lb., gross weight 3,270 lb., fuel 58 gal., oil 6.6 gal. Construction: dural monocoque fuselage, enclosed cockpit; low-wing with plywood-covered leading edge, fabric-covering structure consisting of two steel spars and wood ribs, streamline wire bracing above and below; tail group, fabric covering structures having dural or steel tube spars and wood ribs, elevators and rudder are balanced; individual leg cantilever type landing gear. Performance: maximum speed 261 m.p.h. at 14,100 ft., rate of climb 2,670 ft. per min. Engine: Nakajima III, 550 hp. at 1,950 r.p.m. at 13,120 ft. (maximum 700 hp. at 2,100 r.p.m.).

Listed as "commercial or military" aircraft and therefore of significance in this study is the low-wing monoplane Koken, manufactured by Tokyo Gasu Denki K.K. Specifications—span 88 ft. 6 in., length 49 ft. 2 in., height 11 ft. 9 in., wing area 936 sq.ft., power loading 26.3 lb. per hp., wing loading 22.3 lb. per sq.ft., empty weight 7,840 lb., gross weight 20,950 lb., fuel 1,850 gal. Construction: all-metal monocoque fuselage, Alclad skin; wing, all-metal single steel spar; all-metal tail group; retractable landing gear, tail wheel. Standard equipment: variable-pitch metal propeller. Performance: maximum speed 133.5 m.p.h., cruising range 9,315 mi. Engine: Kawasaki 800 hp.

Not a fighting craft but incorporated in the Japanese Air Corps is the Tatikawa two-place light ambulance, with a Cirrus Hermes IV engine, 130 hp. at 2,100 r.p.m. Specifications: span 32 ft. 9.5 in., length 25 ft. 10 in., height 7 ft. 9.5 in., wing area 236.7 sq.ft., power loading 17.65 lb. per hp., wing loading 9.66 lb. per sq.ft., empty weight 1,328 lb., gross weight 2,294 lb. Construction: welded steel tube fuselage, enclosed two-place cabin.



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Airplane Hydraulics

(*Continued from page 71*)

cases, the selector valve has a spring return to neutral so that as soon as the handle is released, the valve will return to neutral by-passing the flow from the pump to the tank and trapping the oil in the cylinder, locking it in that position. By moving the control handle into the "up" position, the fluid is allowed to escape from the flap cylinder and the spring in the cylinder will retract the flaps. At this time, the flow from the pump as well as from the cylinder will be returned to the tank. A flap indicating system advises the pilot of the position of the flaps so that he can release the handle at the desired position, thus setting the flaps in that position. In the full extended position, the fluid will be by-passed through the main relief valve, resulting in the warning signal as with the primary valve. The flap relief valve prevents extending the flaps at excessive speeds and causes them to retract under these conditions thus preventing overloading. A hand pump is also installed as a standby in case of engine or pump failure, with check valves to prevent interflow between the hand pump and the engine driven pump. A strainer is used in all engine pump installations to insure clean fluid and may be installed in either the suction line before the pump or the pressure line immediately after it.

The primary valve is a four-way valve and may be of the three-position latch or the spring return type. The former is preferable in this case due to the landing gear actuation being either full extension or full retraction. The short period of by-passing through the relief valve is not considered objectionable.

The secondary valve may be either a three-way as illustrated, or a four-way valve, depending on whether the actuating cylinder is of the spring return or the two-way actuating type. In this case, the spring return or latch type valve can be used, the latter being preferred as intermediate positioning of the flaps may be desirable and better control is thus obtained.

The advantage of the above system is its simplicity, in installation, operation, and low cost. The only disadvantages being that the flaps cannot be operated during the period that the landing gear is being retracted or extended; and the landing gear cannot be operated while the flaps are being extended, although after a retraction they may be. However, many pilots are satisfied that it is practical to actuate one system at a time and therefore do not consider this system objectionable.

A very popular hydraulic system used in aircraft is illustrated in Figure IV. In this circuit, a power control valve is employed between the pump and the hydraulic components. Essentially, it is a hand shut off valve with an automatic turn on feature which permits the circulating of fluid from the power driven pump to the reservoir without imposing the continuous load on the pump by developed high pressures.

The power control valve is generally located just aft of the firewall in the cockpit of the airplane, ahead and in between the landing gear and flap control valves. When pressure is not required in the system, the knob on the power valve is in the "out" position and the output is directed unrestricted through the valve back to the tank. To actuate the landing gear, the handle of the selector valve is placed in the "up" or "down" position and the control knob on the power valve marked "push" is pressed inward. The fluid from the pump is now directed into the hydraulic system and into the landing gear cylinder. As pressure builds up, the cylinder will retract the landing gear until the full limit of the stroke has been reached. Excess pressure developes in the system which unlocks the piston in the power control valve, allowing the "push" knob to come to the "out" position, and opens the by-pass port to the tank, permitting the fluid to by-pass unrestricted to the tank.

To extend the landing gear or to operate the flaps in either direction, the selector valve handle of the desired component is placed in the chosen position, the power valve knob pushed inward. The same cycle as described above will take place, resulting in the power valve knob in the "out" position after hydraulic actuation.

A surge cylinder mounted outside the cockpit and close to the power control valve is connected to it. The purpose of this cylinder is to absorb momentary rises in pressure above a set pressure in the power control valve locking mechanism, thus preventing the disengaging of the power control valve before the landing gear is completely up. However, if the power control valve should become disengaged before complete actuation is obtained, the control knob on the power valve is pushed in again.

A hand pump is incorporated in the system, conveniently located for operation by the pilot in case of engine pump failure. Check valves are included to prevent flow through the engine pump or its by-pass when the hand pump is used, or flow through the hand pump when the power pump is used.

A master relief is not essential in this system as the power valve will by-pass after excessive pressures are reached. A relief valve is placed in the flap extension line to prevent lowering the flaps at high speeds and thus prevent overloading of the flaps.

As the use of hydraulic equipment becomes more extensive, automatic regulation and operation with the least amount of effort from the pilot becomes imperative. The greater the quantity of hydraulic mechanism used, the greater the requirements from the pump, which reaches a point such as in our transport planes and larger military planes where two pumps, one mounted on each engine, are used. In the largest land planes, due to the employment of much hydraulic apparatus and added safety features, four pumps are used to operate and stand by the hydraulic system.

A complete and comprehensive system is shown in Fig. V. This system is divided into four parts.—

(a) Power supply or pumps.
(b) Pressure storage and regulation.
(c) Hydraulic controls or selector valves.

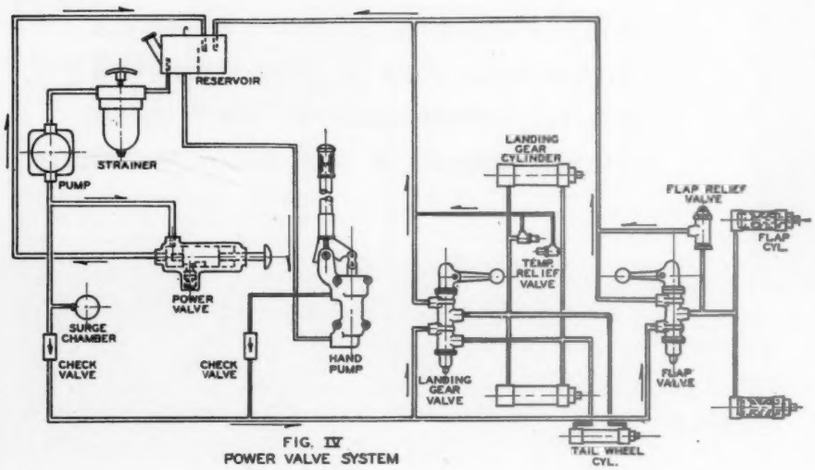

FIG. IV
POWER VALVE SYSTEM

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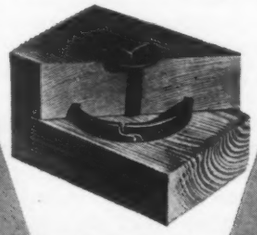

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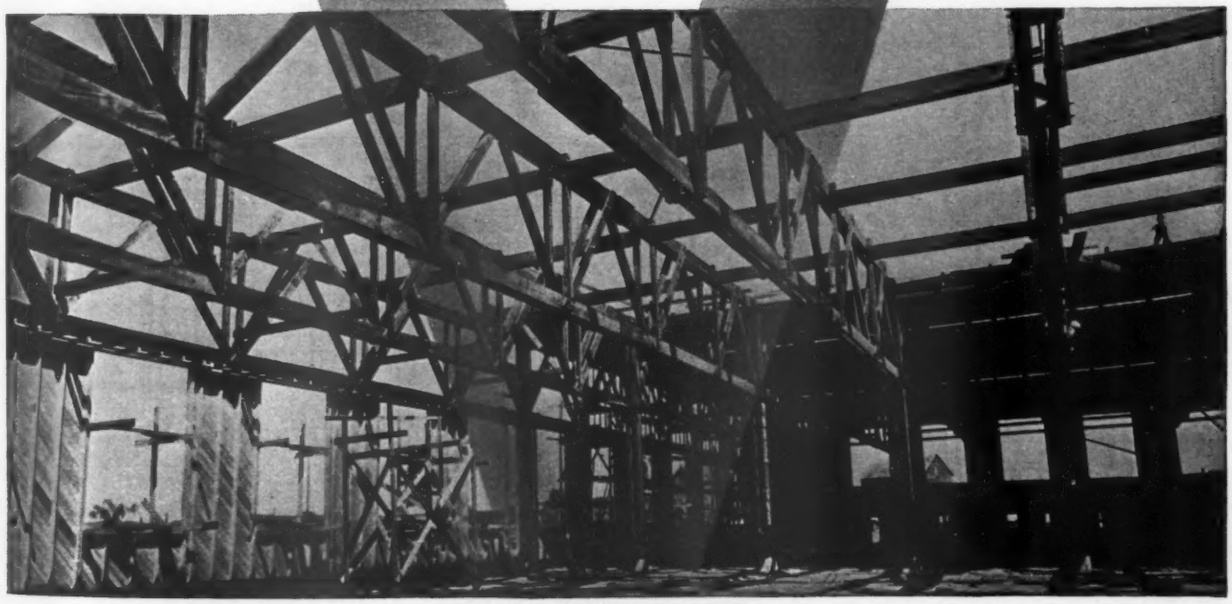

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(d) Actuation mechanisms or cylinder.

In the case of multiple pump installation, a three-way selector valve is installed in the pressure lines so that either pump can serve the hydraulic system or direct the flow into the automatic pilot system. Choice of which system to serve with a particular pump can be made by the pilot by setting the selector valve as only one pump is used to supply each system at any one time, in the case of two pump installations.

Pressure storage is obtained in a pressure tank or "accumulator". This may be of the spring loaded type where pressure works against a set of springs, or the air loaded type. The latter type is quickly replacing the spring type due to its capability of accumulating high volumes and its lightness. Essentially it consists of a hollow sphere with a synthetic rubber bag or diaphram dividing it into two chambers, one for oil, the other for air. The air is preloaded anywhere from 300 to 600#/in.^{2}, depending on the requirements of the accumulator and its capacity of operating any given or all the hydraulic components. This of course determines its volume requirements and its size.

Aside from acting as a pressure storage reservoir, the accumulator acts as a surge chamber and shock absorber to dampen out pressure surges and shock from the system.

The fluid side of the accumulator has two connections, generally a tee coupling, one side leading to the hydraulic controls and mechanisms and the other to the pressure regulator or unloader valve. Since the pump is directly connected to the engine and therefore running during the whole time that the engine is in use, pressure would be constantly delivered to the hydraulic system. This is objectionable because power not used will be taken from the aircraft engine and dissipated as heat, as explained heretofore. The unloader valve is placed between the pump and the system to overcome this difficulty. This valve has two distinct functions, one, to maintain the pressure in the accumulator and thus keep the hydraulic system within a pre-determined and set range of pressures. Second, to completely unload and by-pass the fluid from the pump to the reservoir with no appreciable pressure drop. Generally, the valve operates as follows: When the pressure in the system attains the upper limit of the pressure range for which the regulator is adjusted, a valve opens automatically and the output of the pump is by-passed back to the reservoir, this is called unloading. At the same time, a check valve incorporated in the unit prevents back flow or loss of pressure in the system. When the pressure drops to the lower limit of the predetermined range (usually about 200#/in.^{2}), the valve closes and the pressure is directed into the accumulator and thus the system, which is known as loading. The pressure loss above mentioned may be due to leakage in the system or internal leakage in the regulator valve. With the proper valve installation, the accumulator will compensate for this leakage so that the time interval between unloading and loading may range upward from a half hour, depending on the size of the accumulator and the pressure range. The better type of unloader will unload and load constantly at exactly the set pressures. High operating pressures are always and instantly available to all the hydraulic mechanism. As soon as any of the control valves are opened, the pressure from the pump is made available to the hydraulic mechanism.

A relief valve, known as the "Master" or system relief valve, is installed between the accumulator and the reservoir. It serves as a safety vent in case the unloader should fail to unload, thus preventing excessive pressure from building up in the system. This valve is set to open at a pressure somewhat higher than the unloading pressure as set in the pressure regulator or unloader valve.

Two pressure gauges are installed in this system; one between the pump and the unloader valve and the other between the accumulator and the master relief valve. The former gauge should read zero during the time that the system is not being operated and the pump pressure is by-passing through the unloader valve. When the valve is loading, this gauge will indicate the build up of pressure until the unloading point is reached, where the gauge will immediately drop to zero. The other gauge will indicate the pressure in the system at all times. This gauge will read within the pressure differential of

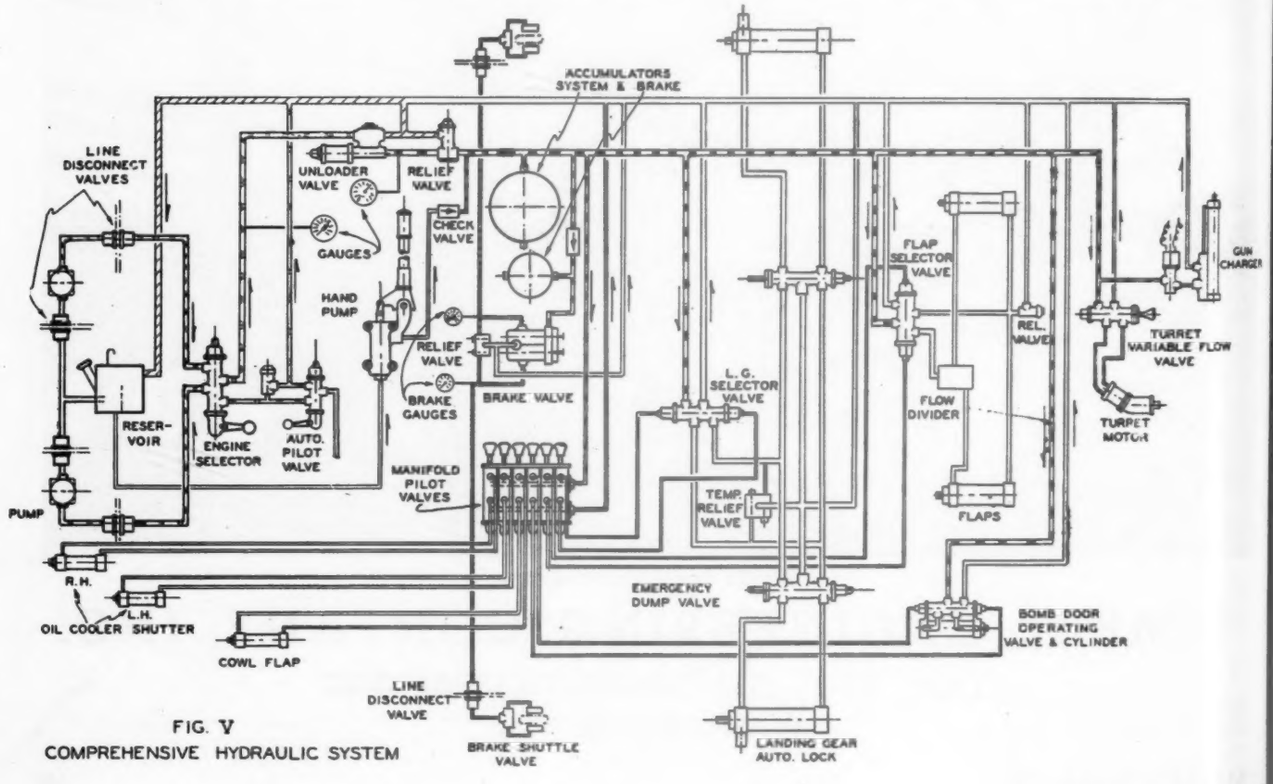

FIG. V
COMPREHENSIVE HYDRAULIC SYSTEM

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how to use them
how to test them
how to repair them
how to install them

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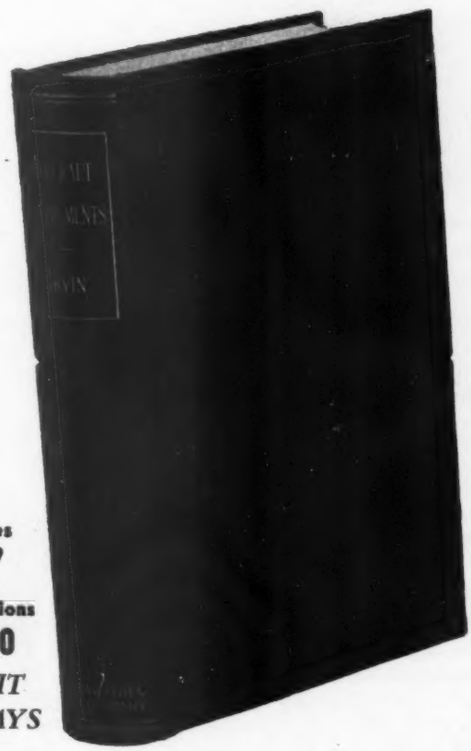

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the unloader valve, indicating both the unload and loading pressures. The gauge reading may drop below the low limit of the pressure range if the supply is not sufficient to replenish the pressure drop immediately. However, this pressure will build up again as the cylinders fill up, when the hydraulic mechanisms are opened to the pumps. If the pressure drops below the limit when the actuating mechanisms are not in use or in the event it does not build up immediately, the pilot realizes that either the source of supply has been cut off through the malfunctioning of the pumps or the unloader valve, or there is a large leak in the pressure line. In the same way, if pressure beyond the set unloading pressures is obtained, the pilot realizes that the unloader valve is not by-passing the pump pressure.

A hand pump is provided in case of loss of power or any other reason that pressure is not being supplied to the accumulator. The suction line of the hand pump is connected to the very bottom of the reservoir whereas the engine suction lines connect two or three inches above the bottom. In the latter case, this is desirable because a reserve supply is thus provided for hand pump operation when the fluid used by the engine pump is lost. The hand pump is meant for auxiliary use. In the event the pumps are not supplying pressure due to lack of fluid in the reservoir, the hand pump may still draw on the volume below the engine pump take-off lines. The pressure line of the hand pump connects aft of the accumulator line. Check valves are employed in this line to prevent accumulator pressures in the hand pump when it is not in use. In some cases a check valve is supplied to prevent pumping up the accumulator and fluid is directed to the mechanism directly.

Although selector valves in most cases differ very little in operation, being either three- or four-way selectors, the construction of the valves and the methods of operation and installation may differ with different airplanes. Since it is not the purpose of this paper to discuss the construction of the mechanism beyond an explanation of their operation, the subject of controls will be limited to a few general installations. In most cases, the selector valves which determine the selection of the mechanism and the direction of its operation, is mounted directly in the cockpit of the airplane and connected to the pressure line leading from the accumulator. These valves are mounted on a control panel within easy reach of the pilot or co-pilot.

In modern airplanes it has been found undesirable to mount the selector valves in the cockpit. Due to the undesirability of bringing large pressure lines into the pilot's compartment. Line failures in larger lines constitute a danger to the flying personnel as well as to valuable instruments in the cockpit. Aside from this, since each valve has four lines coming and going from it, multiplicity of mechanisms requiring five or six selector valves will result in a maze of hydraulic lines, resulting in a tangle. Large areas exposed to gunfire in military ships makes this undesirable. Aside from this, the weight of long large diameter lines is prohibitive. Manifolding the pressure and return lines will help somewhat although the installation will still be cumbersome. One solution to this problem is a remote control unit.

The illustrated hydraulic system in Fig. V shows a bank of small pilot valves mounted on a pressure and return manifold. $\frac{1}{8}$" or $\frac{3}{16}$" lines lead to the manifold as well as from the pilot valves to the individual selector valves. The pilot valve that is mounted on a control panel may be of the push button or lever type and can be operated very much like an electric light switch. The landing gear and flap control valves may be mounted in the wing as close to the respective operating cylinders as possible. In single cylinder installations, the valve can be directly mounted on the cylinder to be operated with cowl flap, intercooler flap, trim tabs operating cylinders, because of their small capacity they may be directly operated by an individual pilot valve mounted on the control panel and manifold.

The bomb door in a bomber installation can be operated with a pilot valve in the gunner's compartment mounted on a pressure and return line manifold containing the bomb release operating valves. The bomb door control valve may be mounted in the bomb bay close to or on the operating cylinder.

A special selector valve mounted in the machine gun turret and operated by the gunner may directly actuate the cylinders controlling the operation of the turret.

The remotely controlled mechanisms, such as the landing gear and flaps, operate as follows: When the handle on the pilot valve is set in the "up" position, pressure is directed to one side of the piston on the secondary control valve, displacing it away from that side. Fluid on the opposite end of the piston is forced through the pilot valve into the return line. The pressure line leading to the selector valve supplies the pressure to retract the cylinder, while a return line permits the exhausted fluid to be returned to the reservoir. These lines are considerably larger than the pilot lines and do not enter the cabin of the airplane. When the pilot valve is placed in the neutral position, the pressure on both sides of the secondary valve is equal and a spring returns the latter valve to a central or neutral position, thus hydraulically locking any pressure in the cylinder. This feature is optional and has become popular only in the flap system. In all other cases a neutral position is not necessary. To extend the cylinders, the handle of the pilot valve is brought to a "down" position, pressure then flows into the opposite end of the secondary valve before mentioned, acting on the piston, thus displacing the plunger, allowing pressure from the main line to act on the piston of the cylinder to protract it.

Special valves and fittings incorporated in the comprehensive system in Figure V are as follows: Line disconnect valves are mounted on the firewall of the engine so that the lines may be removed for engine or pump overhaul and replacement, without losing the pressure in the system. They are also used as a means of connection to an outside source of pressure for testing the various parts of the system. These valves may be distributed at various points in the system, so that pressure can be maintained in one portion while another portion is removed for repair. An emergency dump valve operated by hand, is placed between the selector valves and cylinders to permit the valve to release the pressure in the actuating cylinder and by-pass it to the reservoir, while the pressure in the system is at the same time maintained. This is done so that the landing gear can be manually operated or repaired in case of failure.

The airplane brake system may be independent of the main hydraulic system and in that case may be operated from a master cylinder in a closed circuit. In large airplanes, it is more practical to operate the brakes by utilizing the pressure of the main hydraulic system. In the best type of brake system, as shown in Figure V, pressure is transmitted to the brakes through a power control valve operated by the pilot, where each wheel brake is operated independently. The brake system has its own accumulator with a proper capacity to supply the brake cylinders with sufficient pressure to fully operate them three or four cycles. Since each brake has two cylinders, a shuttle valve is placed between them so that a leak or break in one cylinder or its line will cut off the flow to that cylinder thus maintaining pressure in the other. A check valve is incorporated in the pressure supply line adjacent to the power brake control valve, allowing the fluid to pass into the control valve but preventing its return. Line disconnect valves are placed in the brake lines so

(*Turn to page 162*)

WHEN first they introduced the service—a full dozen-and-a-half years ago it must be, now—old Uncle Ezekiel wasn't one whit impressed. "One of they noo-fangled thingummies, drat'em," he'd mutter, waving his much-charred corn-cob vaguely at the skies as the homing ship roared overhead. "Wouldn't say thank'ee for 'em, no-how. Spoilin' my rest." And he'd shake his grizzled head slowly from side to side and purse his lips vigorously in unsaid (but potent) criticism.

Today, when the great silver ships come gliding down out of the Eastern sky with the sun splashing vivid high-lights on metal cowling and wing-tips, old Uncle Ezekiel scarcely looks up from his chair in the porch. His one action is to call over his shoulder in a cracked, petulant oice: "Late again there, Martha. 'Tis five o'clock by the airybuzzer—**and where's my cawfee?** If yez was only half as efficient . . . ."

"Ay, them planes are real efficient," says Uncle Ezekiel. But he knows nothing of the hours and days and months of hard, unrelenting work in drawing-office, laboratory, factory and hangar that have gone to **make** that efficiency. He knows nothing of the calculations and cross-calculations, the checking and re-checking up to the nth. degree and beyond. He knows nothing, for example, of the importance of competent filtration.

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Navigation

(*Continued from page 53*)

The directional indication of the aural null system is based upon the very pronounced variation in signal volume that is heard as the plane of the loop is changed in relation to a transmitting station to which the receiver is tuned. Since the loop is most efficient as an antenna in line with the plane of its windings, the strongest signal is received with the plane of the loop directed toward the transmitter. This position is usually termed the "maximum" or, less commonly, the "antistatic" position. Conversely, since the loop is least efficient in a direction perpendicular to the plane of the windings, either no signal or a signal of minimum volume is heard when the plane of the loop is placed at 90 deg. to the station direction (flat side of the loop toward the transmitter). This is termed the null position. Refer to Fig. 2.

This diagram illustrates the maximum and null positions of the loop in relation to a transmitter. The position of the null pointer on the azimuth scale within the cockpit is also shown for each position. Some azimuth dials use two sets of pointers rather than the one as shown in this figure. This is not necessary, however, since the maximum and null positions are always automatically 90 deg. apart. It will be noted also that the aural null loop completely fails to furnish one very important factor in the determination of direction. That is, while the signal response of the loop will indicate the direction of a line through the transmitter, it does not indicate on which side of the loop the transmitter is located. In other words, only a line of bearing is furnished, and until some other means is used to solve the difficulty, it is possible to make a 180 deg. error in the determination of station direction. This is commonly called 180 deg. ambiguity and is common to all direction finders of the aural null type. Certain types of direction finders, however, combine a loop with a straight wire antenna in such a manner that this 180 deg. ambiguity is eliminated. In this case the term "radio compass" is more descriptive than direction finder.

Use of Null

While offhand it may appear illogical, all direction finding with the aural null loop is done with the null position. The desired radio station is tuned in and identified and the loop rotated until the signal either fades out entirely or reaches a minimum. With proper volume setting on the receiver, this null position is considerably sharper and easier to locate than the position of the maximum signal. This is shown by Fig. 3.

Assume the dotted circles indicate the signal strength pattern about a loop. The length of any line from the loop center to any point on the dotted circle will represent the signal strength received at that angle. Obviously, as has been mentioned before, the strongest signal will be received in line with the plane of the loop and, theoretically, a zero signal level at 90 deg. to that position. Moreover, it will be noted that the change of signal intensity is much more rapid as the null position is approached than near the maximum position. This fact makes it possible to establish the null position to within a very few degrees; whereas the maximum may be quite indefinite. In addition to this, the human ear is able to distinguish differences in signal intensity at low levels much more accurately than at high levels.

Use of Maximum

While the maximum position is not used for direction finding, it does provide a very valuable means of receiving radio signals through static interference. Two factors contribute to this action. First, the electro-static shielding encasing the loop windings tends to minimize the amount of static discharge picked up by the windings; and secondly, use of the loop in its most efficient position furnishes a high signal level in relation to the sensitivity level (governed by the volume control of the receiver) carried in the receiver. In other words, using a low volume control setting and the loop in the maximum position provides a combination of low noise level to high signal level which makes reception through static interference possible.

Null Width And Bearing Accuracy

Although it should be clear from the foregoing discussion why the null position is used in preference to the maximum for direction finding, it should not be assumed that a null always provides an exact bearing on the transmitter. In this respect radio bearings by the aural null method leave something to be desired. A visual bearing taken by a surveyor's transit, for example, can be determined with split degree accuracy; an aural null radio bearing taken from an aircraft is difficult to determine closer than two or three deg. The primary reason, of course, is that the human ear is much less efficient in discriminating between minute differences in sound intensity than the eye in distinguishing differences in angular position. Thus the null is almost never an exact point which can be read to the degree on azimuth scale but rather a zone varying from two or three deg. in width to as many as 30 deg. The resultant bearing then is necessarily an approximation arrived at by visually splitting the null width on the azimuth scale.

Volume and Null Width

Thus, of fundamental importance for accurate bearings with the aural null method is proper control of null width. This is directly dependent upon the strength of the radio signal being received in the headphones. A high signal volume produces a sharp null, while a low volume results in a wide null.

Signal volume in the headphones is the product of several factors. Basically, these are inherent receiver sensitivity plus volume control setting and transmitter power and distance. Receiver sensitivity and transmitted power are constant for any one combination. This leaves distance and the volume control as the variable factors in determining headphone volume and thus, null width.

Fig. 4 shows the effect of signal volume in determining null width. The loop null position is directed at the transmitting station. The broken line circles radiating from the loop represent the signal volume patterns for two different volume levels—AA′ representing a low volume and BB′ one relatively higher. The straight line OX (drawn of arbitrary length for purposes of illustration) represents the minimum signal volume audible to the average ear.

It will be apparent from the diagram that no signal will be heard until the volume of the received signal is equal to the minimum volume for audibility. With the lower volume pattern AA′, this means the loop must be rotated in either direction until point a or a′ coincides with X. With this volume level of received signal a total loop rotation of 50 deg. is thus allowed during which no signal is heard. This, in effect, becomes a 50 deg. null. By raising the volume level to BB′ the signal will become audible with rotation to either b or b′, thus making a null of only 25 deg. Naturally, these null widths are excessive for actual practice but are used here for sake of easier illustration. The point to be emphasized is that under normal conditions null width is directly controlled by volume. Volume in turn is controlled both by the receiver volume control setting and distance from the transmitter. Many pilots using the loop in the null

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Mr. Walter H. Beech,
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Dear Mr Beech:

For some time, for that matter for some months I have been thinking of writing to you, telling of the wonderful performance of our Beechcraft Seaplane. The word WONDERFUL really doesn't cover or describe what I would like to impart to you of the performance of this great plane.

It has stood up now for almost two years under the most trying tropical weather conditions, and has taken me in and out of places considered "impossible" for any plane. We have landed on streams that would be considered as creeks at home. Slipped, with flaps down, onto rivers in between mountains towering four thousand feet on either side; onto swift running rivers in between rapids. It took me over a year though to make up my mind to go into one place where we have work among the Dyaks. I mean that place is TIGHT But after almost two years of flying with the Beechcraft, I know that it can take the tough spots.

"We have landed on streams that would be considered as creeks at home . . ." as the photo shows.

And with its added gas tanks, we go places. Have made several long non-stop flights of from five to six hours. Two of these long hops were x-ocean with nothing but rough water below us for four hours, and if it hadn't been for my confidence in the Beechcraft and the fine Jacobs motor, these flights wouldn't have been especially pleasant. Two of these long flights were made when the plane had to be flown to Java for inspection. Several flights have also been made to Makassar from our base here in Tandjongselor, hops which necessitate quite a bit of x-ocean flying too. But whether the trip be a one, a two, or a five hour hop, I always take off with confidence, for I'm riding the clouds in a Beechcraft.

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position fail to recognize this relationship with resultant difficulties in obtaining a null of proper width and maintaining it as distance to the station is increased or decreased.

Types of Bearing

As mentioned previously, the position of the loop null is indicated to either pilot or navigator by means of an azimuth scale and a pointer which rotates with the loop. While several variations of azimuth scale design are used, the simplest type is graduated uniformly clockwise from zero through 360 deg. All types are mounted in the airplane with the 0 deg. and 180 deg. positions parallel to the longitudinal axis.

This means, then, that all bearings *read directly from such an azimuth scale are only angular measurement in relation to the nose of the airplane.* Such bearings are commonly termed relative or loop bearings. Refer to Fig. 5.

It will be evident that such a relative bearing by itself does not furnish a geographical direction or bearing. For example, in Fig. 5, if the airplane's heading* were unknown, there would be no means of orientating the relative bearing of 30 deg. to north. Thus to reduce a relative bearing to a geographical one, it is necessary to combine it with the airplane's heading as determined from the magnetic compass or directional gyro. This relationship is shown graphically in the figure.

Since, however, the airplane's heading may be taken with respect to either true, magnetic, or compass north, we have three similar variations of geographic bearing. These are true bearing, magnetic bearing, and compass bearing. Which will be used is necessarily governed by the particular problem at hand. This will be discussed in a following article.

To obtain a geographic bearing mathematically it is only necessary to add the degrees of relative bearing to the appropriate heading in degrees. From Fig. 5 we see:

1. The *true bearing* equals the true heading, 60 deg., plus the relative bearing 30 deg. or 90 deg.
2. The *magnetic bearing* equals the magnetic heading, 70 deg., plus the relative bearing, 30 deg. or 100 deg.
3. The *compass bearing* equals the compass heading, 75 deg. plus the relative bearing, 30 deg. or 105 deg.

When the arithmetical sum of heading and relative bearing is more than 360 deg. it is, of course, necessary to subtract 360 to obtain the bearing.

For example, a heading of 300 deg. plus a relative bearing of 80 deg. equals 380 deg. minus 360 deg. or a 20 deg. bearing.

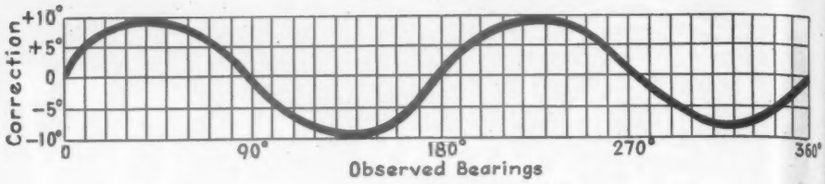

FIG. 6
Correction Curve

Quadrantal Error

Just as the accuracy of the magnetic compass is adversely influenced by local magnetic fields in the airplane, so are the directional indications of the loop influenced by the metallic structure of the airplane itself. Sometimes, this type of loop error is termed loop deviation due to its similarity to compass deviation. Preference, however, is given to the term "quadrantal error" which, while less descriptive, is less likely to cause confusion with compass deviation.

Quadrantal error, in brief, is caused by the refraction or bending of the incoming radio waves by the metallic structure. This, of course, means that the amount of angular rotation of the loop needed to establish a null on an incoming wave will not be an accurate indication of the station direction. Unless the amount of error is known and applied in some form to compensate for this situation erroneous bearings will result.

The amount of quadrantal error for any loop varies as the null position is rotated through 360 deg. in relation to the airplane's nose. The same pattern of error prevails between any two airplanes of the same type and mounting the loop in similar positions.

The quadrantal errors for any specific airplane type and loop mounting can be determined in much the same manner as compass deviation. First, the azimuth scale is so adjusted that a signal arriving from dead ahead will give a null at 0 deg. on the scale. With this adjustment it will be found that the bearings as read on the azimuth at the 90, 180, and 270 deg. points will also be accurate without correction. In between these cardinal points, bearings as indicated on the azimuth will be in error. These errors in successive positions can be determined by "swinging" the ship on the ground while taking bearings on a near by transmitter and checking them by visual sights (using a pelorus) or preferably, by accomplishing the same procedure in flight. Greatest error invariably takes place midway between the cardinal positions.

Three common ways for applying the necessary corrections for quadrantal error are in use. Fig. 6 illustrates a typical correction curve by which the required arithmetical correction to be applied to any observed bearing may be ascertained.

Fig. 7 illustrates the corrected azimuth scale method of applying the corrections. Here the divisions of the scale are so adjusted that the pilot or navigator can read the corrected bearings directly. A third method is to incorporate a specially ground cam between the loop and azimuth pointer so that the correction is made automatically. This eliminates the need for either correction curve or distorted scale.

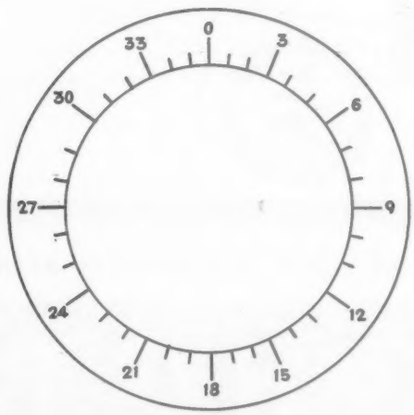

FIG. 7
Corrected Azimuth Scale

Night Effect

In non-technical terms, "night effect" as applied to the operation of a directional loop, consists of shifting (either slowly or rapidly) and indefinite nulls. Sometimes it may be impossible to obtain a null, and then again, there may appear to be two nulls. All loop type direction finders are subject to these night effects although the airplane D/F loop is much less affected (during flight) than a ground D/F loop.

Generally speaking night effect phenomena are most pronounced during sunrise and sunset periods. While some degree of this trouble can be expected

* Note: It is important to recognize the exact distinction between the navigational terms, heading and course. Heading is the direction toward which the airplane's nose is directed and obtainable from the compass. Course is the direction in which it is desired that the airplane should travel from one point to another. They differ, of course, because of wind drift.

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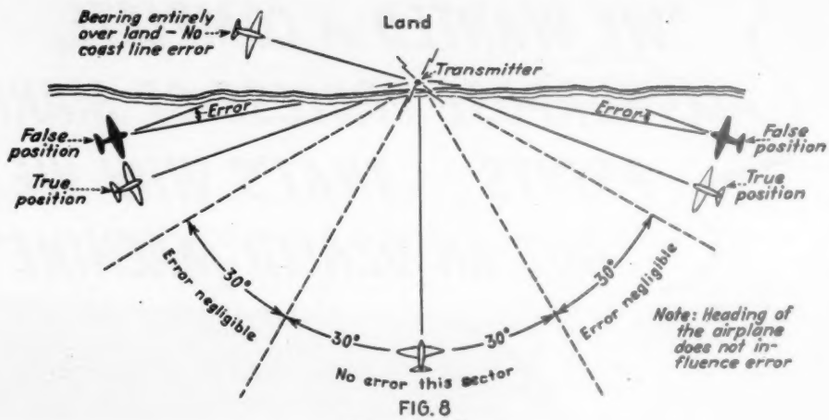

FIG. 8
Coast Line Error

in hours of total darkness, it is not experienced during daylight. Likewise, when it is experienced, it usually disappears when the plane comes within some minimum distance from the station (varying from 20-50 miles).

It is a well known fact that any transmitter radiates one portion of its energy in the form of a ground wave which closely parallels the earth's surface, and the remainder, as a sky wave which leaves the surface at a sharp angle. With present equipment, direction finding is accurate only with the ground wave. Usually the sky wave is not received. At such times as it is received, the two types of waves influencing the loop from different angles produce night effect phenomena. It is generally considered that the behavior of the sky wave portion of radio signal is closely related to the height above the earth of the so-called "Heavyside layer" of ionized gases. This layer changes in altitude from day to night, summer to winter, and from high to low latitudes.

From practical experience it has been found that night effects are more pronounced the higher the frequencies used. This is one of the reasons for preferring low frequencies for direction finding. Likewise, these effects are less troublesome during the summer season than during winter. This seasonal difference becomes more noticeable as the latitude increases.

Terrain Effects

Effects of similar nature to those described are produced by the varying character of the earth's surface itself. The most pronounced errors caused by terrain are bending or refraction of the incoming waves so that a null obtained may be quite an erroneous indication of transmitter direction from the airplane. Bearings taken on stations in mountainous terrain are extremely erratic for this reason. In similar fashion, radio waves traveling over alternate areas of land and water frequently produce erroneous bearings.

Fig. 8 illustrates a similar type of effect which may be experienced flying over water and near to a coast line. This is commonly termed coast line effect. It will be noted that the errors are greatest when the bearings are within 30 deg. of parallel to the shore line.

All of these errors due to terrain will be found to differ considerably with variation in the terrain conditions, and as a general rule, they are very hard to evaluate. Low altitudes generally make the errors more pronounced, and particularly so if high terrain intervenes between the transmitter and the aircraft.

Conclusion

While it is impractical in an article of this length to present more than the basic principles of radio loop operation, it is felt a proper understanding of those discussed should be considered a prerequisite for use of the loop in navigational procedure. This aspect of the direction finding loop will be discussed in a following article.

Airplane Hydraulics

(*Continued from page 156*)

that the wheels and brakes may be removed and repaired while maintaining pressure in the hydraulic system. A pressure gauge is connected to the brake lines to indicate the brake pressure. Temperature relief valves connected in each brake line prevent brake seizure because of a build-up of pressure due to temperature increases when the airplane is parked. A plunger type parking lock control is located on the control pedestal for locking the brakes when desired such as while parking.

In operation application of toe pressure to the rudder pedals causes a piston and valve operating pin in the control valve to move up, and lift a ball from its seat, thus connecting the brake and pressure lines. Fluid will then flow into the brake line until the piston pressure and brake pressure are equal; at this point, the piston and pin will again be forced down permitting the ball to seat and relieve the brake from further increase in pressure. This operation should be without lag. When the toe pressure is released the piston moves down, unseating the valve operating pin. As soon as the piston and pin are separated, two holes in the piston are uncovered allowing the fluid to flow out into the reservoir, thus relieving the brake pressure.

Space does not permit discussion of every type of hydraulic system used in the aircraft industry, however, all of the principles, with the exception of the electric hydraulic system, have been fully expounded.

An electric hydraulic system is one with which the pump is operated by a separate electric motor. Remote operation is obtained by a system of solenoid operated valves and limit switches. The advantage of this system lies in the fact that power is not taken from the engines to operate the system. Also, by employing limit switches the electric motor driven pump operates only when supplying pressure to the system to actuate the hydraulic mechanisms. The greatest advantage of all is the fact that hydraulic pressure lines, with the exception of gauge lines, are completely removed from the cockpit of the airplane, this being accomplished by means of remotely operated units made possible with the use of solenoids. The main disadvantage, is the increased weight required by the electric motor and solenoids.

Another hydraulic system not disclosed is the automatic pilot system. The information concerning this may be obtained from the manufacturers of the automatic pilot.

Many improvements have been made in aircraft hydraulics, and many more are expected. New requirements resulting in new and improved equipment, are constantly being brought to light. No attempt has been made to discuss the numerous hydraulic units which go to make up the various systems. This particular subject, the construction and individual merit of the existing hydraulic mechanisms, is now in the process of preparation and is expected to be presented in the near future.

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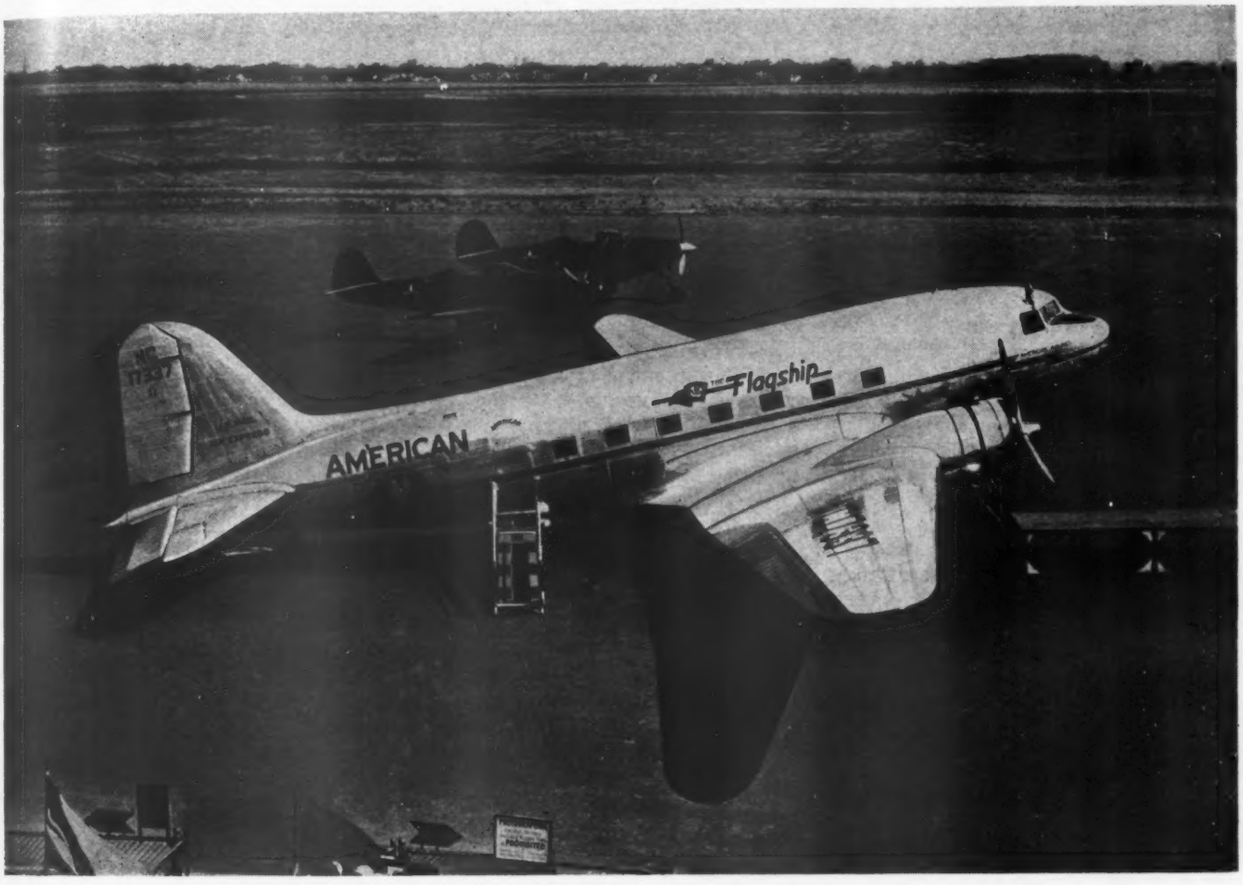

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The New Vega Plant

(*Continued from page 65*)

assemblies will be handled in a like fashion, and so on until the completed ship is assembled.

This cuts down dispatching and stockroom paper work. It breaks up stockroom space, making control easier. Also, it gives us visual control not possible except when we have small reservoirs of parts and assemblies. You can see exactly what stock is in the bins. The lead man is actually a control clerk on stock, and as soon as he runs short, or sees that he is going to run short, he can get quick action by putting in a "hot order". There is need for but few stock clerks under this plan.

This smooth flow of materials begins at the unloading dock. This structure is 50 ft. wide at one end, 10 ft. at the other end, and 325 ft. long. It is covered by a canopy. The wide end of the dock is used for truck unloading. The length of the dock is adjacent to a spur track. A monorail system covers all of the area under the dock canopy and under the mezzanine of the adjacent warehouse.

This large warehouse, separated from the main manufacturing building by a concrete fire wall, is 625 ft. long, 160 ft. at the widest portion, and 125 ft. wide at the narrowest. Of reinforced concrete wall, concrete floor, and sawtooth roof construction, the warehouse has a ceiling of 35 ft. clear head room. The mezzanine floor, 40 by 325 ft., is incorporated, being floor-supported and having 15-foot head room.

The warehouse, other than the mezzanine floor, is serviced by a travelling bridge crane system by means of which it is possible for a man to take a load of material or a piece of equipment from the dock to any part of the warehouse or the manufacturing building without transferring the load.

The manufacturing building covers nearly twelve acres under a single roof, measuring 600 by 850 ft. or 510,000 sq. ft. of working space. A "J" shaped mezzanine having a total floor area of 197,000 sq. ft., bigger than the entire Plant No. 2 of the Vega Company located on San Fernando Road in Burbank, is incorporated in this building to provide sub-assembly area. Large sub-assemblies are assembled on the mezzanine and transferred to the main lines by the overhead crane system, being so placed that they move in a straight line directly to the point of usage.

Under the mezzanine on the ground floor are the fabrication departments, paint shops, processing department, and other sub-assembly departments. Parts are transported to the mezzanine floor by the travelling bridge crane, monorails, and elevators, and adequate stairways are provided for employees.

From one end of the warehouse aluminum sheet metal flows in a steady stream through giant shears and out through a door into the manufacturing building where it is formed by huge hydraulic power presses, drop hammers, power brakes, punch presses and spotwelders into small component parts of the airplane-to-be. Parts of bar stock, tubing, extruded aluminum stock, castings, and forgings leave the warehouse by other doors as they form tributaries to the river of metal flowing through the heat treat, anodizing and chromodizing, cadmium plating and paint departments, thence to Dispatching, to various sub-assembly departments or for storage until used.

At this point we look upstairs to the mezzanine. Here center sections and sub-assemblies are made up and mated in jigs, fuselage parts are made into sub-assemblies and nacelles are assembled. The empennage is assembled and painted, engines are prepared for attaching and electrical, radio, control and instrument assemblies are made up. All these various parts are lowered to the main floor at the proper time when the airplane is ready to receive them.

The first jigs in the downstairs flow of assembled parts are the fuselage jigs, from which the airplane moves into the mating jigs where the center section stub wings are attached and plumbing assembly and installation started. Next the partially completed airplane with nacelles attached is given its base paint of zinc chromate, after which landing gear is installed. From this point on, the airplane moves along the floor on its own wheels.

Immediately the empennage is attached, followed by the engines. Installation of controls is begun and then, midway down the final assembly line, the wings, bomb doors and cabin door are attached. Electrical assemblies, radio system and instrument panel are next installed, propellers are attached and final check is completed before the airplane is released to the flying field.

In a production line of this sort the secret is filling up all the spaces so that everything runs along a smooth, continuously-flowing line. Once the line is completely filled, with no gaps, and the men are completely familiar with their specific duties, production rolls along smoothly.

It is very important that this familiarity be developed. With it, and with the same crew of men working together day after day on a given job, time in man hours will be reduced easily sixty percent after the first 25 airplanes of the two-engine bomber type.

Furthermore, we find that a crew working on a six-day week is more efficient than one on a seven-day week. Sixty hours seem to us at this time to be too many hours in a week for men to work at maximum effort. A 45 to 48 hour week appears to be an economic maximum. Various plans and work weeks have been tried, both here and elsewhere, and it has been found that men who were familiar with their jobs and with the men with whom they work actually turned out more airplanes per week on the shorter week basis than any other. Such familiarity is not possible on a rotated seven day week.

It is surprising how little things may affect production in a big way. For instance, the best men may be taken from a proven production line and transferred to a new line, with the surprising result that production on the proven line increased even though the younger and less experienced men were left on the old line. The reason was that these men were out to prove that they weren't the second-best men. Also, production goes down as soon as the boys know that the parts on which they are working will not be used for a considerable length of time. Such delays have a very bad effect on the morale of the men. We therefore try to keep things moving at all times, because once the men get going they can maintain a tempo. But this tempo can be broken in a day if the men see delivery stoppages, or if parts cannot be procured. Then it may take weeks to regain the old tempo.

Final assembly work at Vega is planned on a four-hour cycle. Men come on at 7 o'clock in the morning, work for four hours, and the line moves. They work for another four hours, the line moves again, and the swing shift comes on for its two four-hour cycles. This four-hour move applies to everything on the assembly line, and everything moves at the appointed hour whether the work has been completed or not. Where a graveyard shift is employed, clean-up work on anything that may not have been completed on schedule is caught up, and in addition there is one four-hour move in the graveyard shift's six and a half hours on the job. Thus, when in full production on an emergency basis, there will be five moves along the assembly line during each 24-hour day.

IN every corner of the land American citizens are asking, "How fast are we building the things we need?" Sperry's activities, linked as they are to the production pace of the aviation and shipbuilding industries, serve as a reassuring index.

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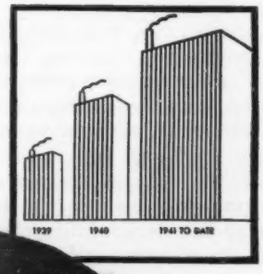
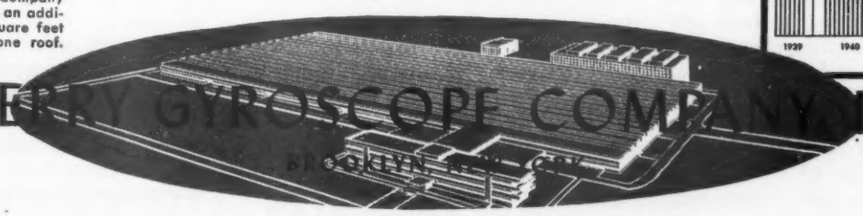


The new Nassau plant of the Sperry Gyroscope Company will make available an additional 1,350,000 square feet —26 acres under one roof.



SPERRY GYROSCOPE COMPANY, Inc.

BROOKLYN, NEW YORK

Eclipse Expansion

(*Continued from page* 55)

num, magnesium, and other non-ferrous quality alloy castings for Eclipse requirements, the foundry is capable of producing—through installation of an in-line production system and improvement of material handling methods—sufficient castings to meet the requirements of numerous other industrial and aircraft manufacturers engaged in defense work.

The foundry layout is such that an in-line production system is maintained with the core, pattern and raw material storage at one end of the building and the shipping department at the opposite end. At no point during the manufacture of castings do any two operations interfere. The foundry consists essentially of individual departments for pattern making, core fabricating, core baking, molding, melting, cleaning, heat treatment, surface treating, inspection and shipping.

To facilitate the molding of intricate designs to improve surface finish and to reduce scrappage, portable sand conditioning equipment and a separate sand control laboratory have been installed in the temperature controlled foundry. To increase production output of cores, the core shop has been equipped with a continuous baking oven and a conveyor system which carries the cores from the benches through the oven to the finishers and finally to the Storage Department. As various alloys of aluminum, magnesium and copper are normally manufactured, the foundry has been segregated into three sections for the melting and casting of these three basic alloys. Molds are hand or machine rammed, depending on design, and placed on the floor between the molder and the furnace where they are poured. After cooling, the castings are removed from the molds, and the used sand piled separately, adjacent to the molder where it remains until reconditioned. The castings are then transported by hand truck to a cleaning department where all gates, risers, etc., are now removed from the castings with either abrasive wheels or band saws.

After trimming and cleaning, castings are divided into various alloy and heat treat classifications and then subjected to heat treatment in electric furnaces. After heat treating, the castings are further cleaned by shot blasting, either by hand or by tumbling equipment, depending on the size involved. To prevent corrosion of the finished castings, aluminum and magnesium castings are given a corrosion protective coating consisting of an anodic and dichromate treatment for aluminum and magnesium respectively. As a large amount of the casting surface is subsequently removed during machining operations, all aluminum and magnesium castings utilized for Eclipse requirements are given a further corrosion protective treatment prior to painting and assembling in finished units.

Operation of the Eclipse foundry has resulted in increased production of Eclipse accessory units due to the fact that scrappage of castings after partial machining has been almost entirely eliminated and a continuous and uninterrupted flow of raw castings to the Production Department maintained.

Metallurgical Department

In order to meet the requirements of minimum weight and compactness as well as to withstand the severe conditions of shock loading and vibration encountered in aircraft installations, Eclipse Aviation has a complete Chemical and Metallurgical Dept. whose function is to control the quality and uniformity of material, both purchased and manufactured, to the most exacting of specification requirements.

In order to assure the use of material of the highest quality, the Metallurgical Dept. has set up a series of material specifications for both raw material and castings. Each lot of raw material and castings manufactured by the Eclipse foundry must be furnished to the Production Dept. with a sample test bar which is given a complete chemical and metallurgical analysis by the Metallurgical Dept. prior to use in the manufacture of equipment. The purchase of raw materials to specifications in accordance with the machining requirements of the Production Dept. has resulted in increased production output due to the fact that machine tools can be speeded up and the life of cutting tools increased.

The Metallurgical Dept. has been equipped with the latest type of precision instruments for the checking of material structure and quality. The high powered microscope known as the "Micro Metallograph" is the metallurgist's tool for the proper control of raw material purchased for the manufacturing of parts subsequently to be assembled into finished units. By the use of the microscope, polished and etched specimens of the purchased material can be examined for soundness and cleanliness of material, presence and segregation of non-metallic impurities, grain size and structure. The microscope also indicates whether the material has been properly fabricated by the mill; for example, whether the material has been hot rolled, cold rolled, extruded, or forged, normalized or annealed, air cooled from the high temperature or quenched in a liquid medium from the high temperature. Proper etching of the specimens with chemical reagents makes it possible for the different structures to become discernible under the high powered lens, which with the proper metallurgical interpretation gives the life history of the material, from the casting of the original ingot through the various fabricating and heat treating processes to the finished form.

All material, whether ferrous or non-ferrous, is purchased according to Eclipse material specifications, which are so rigidly written that they guarantee the highest quality and uniformity of material. In the case of steels, Eclipse specifications are more rigid and the chemical requirements held to closer limits than standard S.A.E. specifications. The purpose of this is to guarantee that only electric furnace steel for aircraft use is furnished and to guarantee that material of maximum machineability for increased production and minimum distortion during hardening is received. The purchase of raw material to specifications providing maximum machineability plus the installation of continuous and automatic heat treating furnaces, are responsible to a large degree for the increased output of the Production Dept.

Planning for Production

The constantly changing requirements of the defense program, from day to day, require a constantly changing program for expansion, both in respect to the selection of additional sub-contractors as well as the purchase of additional machine tools and manufacturing equipment. In order to successfully plan for these requirements, a monthly forecast, based on an 18 month period, is furnished to the Production-Planning Dept. and includes estimated quantities, types and models of various units which have been determined by the Sales Dept. from a careful study of aircraft and engine manufacturers' production capacities for the same period. From this forecast, made by the use of an International Business Machine System, machine loading can be readily determined on the basis of machine hours and machine tools required to produce the equipment specified in the forecast. By means of this machine loading procedure which has been set up after a careful study, and the determination of actual ratios of floor space to both billing and direct labor, a complete analysis of additional sub-contractor and additional machine tool requirements may be readily made. As a result of these monthly forecasts, Eclipse Aviation has been able to determine in

(*Turn to next page*)

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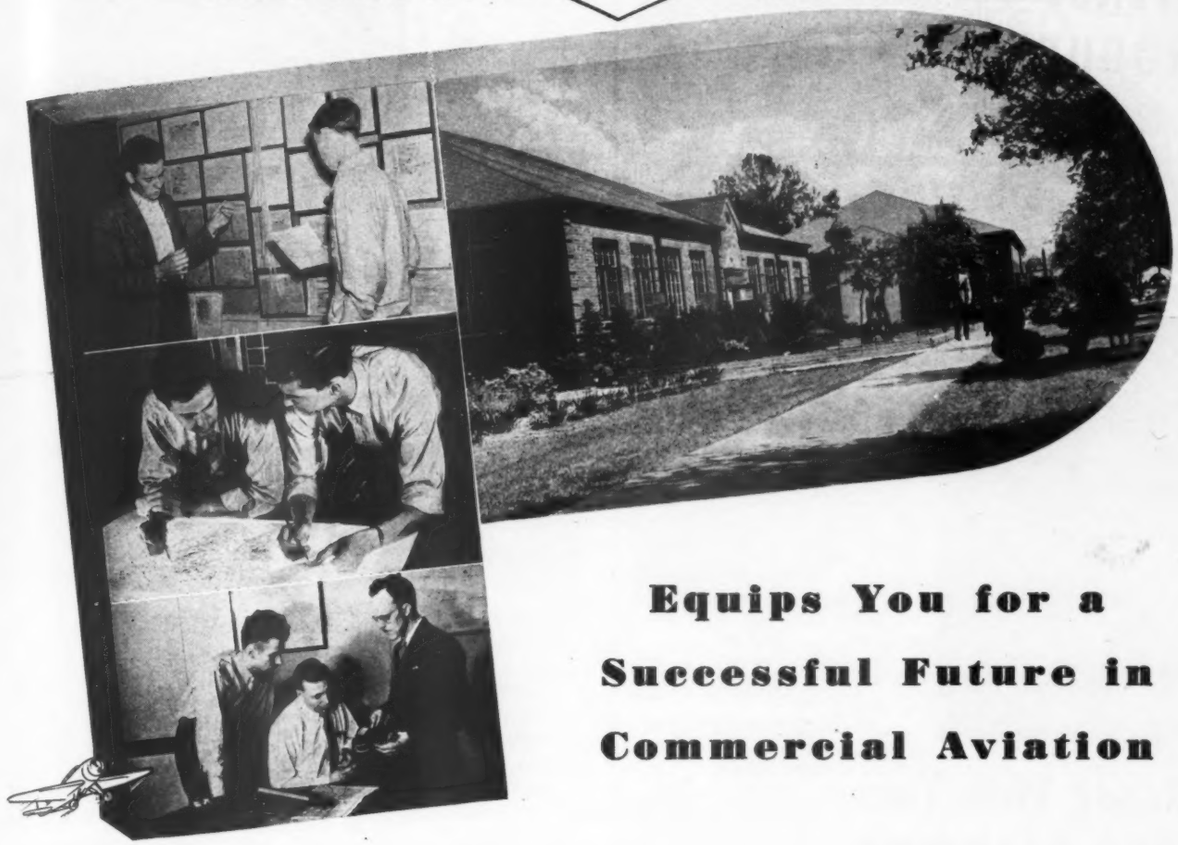

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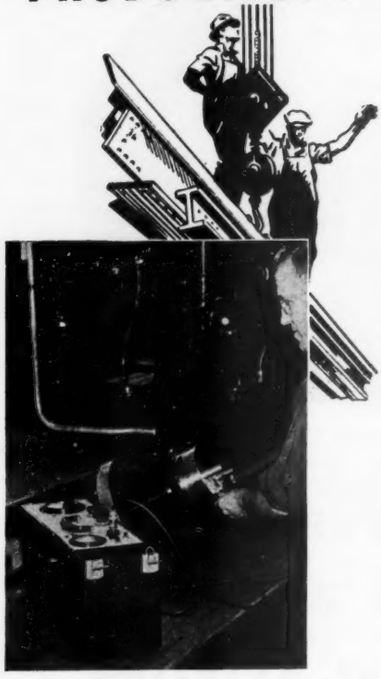

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Eclipse Expansion

(*Continued from page 166*)

advance of actual requirements, necessary machine tools and sub-contractor plant requirements.

Machine Tool Modernization

Installation of the Production-Planning system as outlined above has shown that the problem involved for machine tool expansion is not limited to the purchase of additional equipment of the same type, but is primarily based on the purchase of entirely new equipment which can be used to replace present equipment, thereby obtaining additional production output without increasing actual floor space requirements. As a result of a careful survey of present manufacturing facilities in connection with present sales forecasts, a considerable number of new machine tools; primarily multi-spindle, automatic, horizontal and vertical turret lathes; multi-spindle, automatic screw machines, and grinders of both the external and internal type have been purchased. In addition to the above, multi-spindle drill presses and complete new automatic continuous heat treating and plating equipment have also been obtained.

Other Factors

Another important factor covering the selection of new machine tools has been the manufacture of new and specialized products for which equipment has not previously been available. In addition, careful consideration must be given to changes in design of products in current manufacture which may require special machine tools for fabrication. An example of this condition—where the majority of starter front head housings were formerly made of aluminum alloy on horizontal turret lathes, a change in design from an aluminum alloy to a heat treated steel forging required the use of multi-spindle six and eight station vertical boring machines which are especially adapted for roughing out the steel forgings.

To maintain an in-line system of production manufacture, it is essential that no one individual machine operation lag behind the balance of machine operations. The careful analysis of planning and production requirements and the subsequent purchase of the above mentioned machine tools has eliminated this condition throughout the entire plant at Bendix and at the same time resulted in a substantial increase of production output. (To be concluded next month.)

The brilliance of Vega's fluorescent lighting is clearly shown in this photograph of aircraft stores.

Vega Lighting

(*Continued from page 64*)

Vega manufacturing building covers 16 acres of floor area all under one roof.

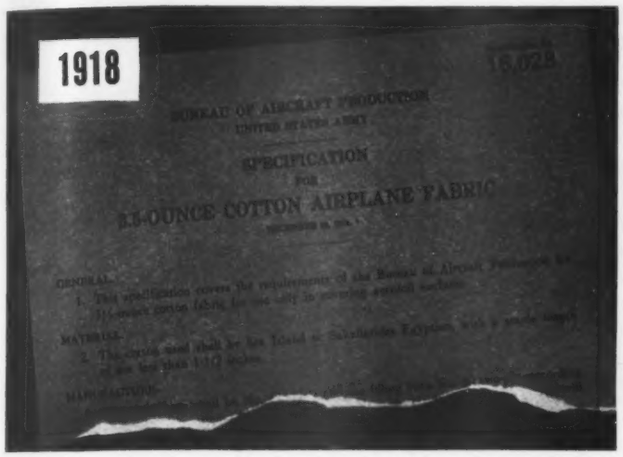
A major problem in connection with this lighting installation was the provision and distribution of electric power. This one plant alone requires several times as much power as the entire residential area of the city of Burbank, in which it is located. It was necessary to arrange for special high-voltage transmission lines directly to the plant, and then to provide eight different electric sub-stations within the factory, each one equipped with from four to eight transformers. Vega engineers estimate the total wattage to be 1,460,960, or almost 2,000 h.p.—sufficient to lift more than 32,000,000 tons a height of one foot in one minute, or to a height of about 1500 ft. during a normal 24-hr. work day.

In addition to the internal lighting problem at the Vega plant it was necessary to provide a high degree of external illumination for night operations. This is done for practical work assistance of people moving around outside the main factory building, and also acts as a protective lighting system to reduce possibility of sabotage. This external lighting is a combination of flood lighting and "street lighting" fixtures.

Since the Vega factory is located adjacent to the runways of Lockheed Air Terminal it was necessary to provide a carefully planned system of obstruction lights to minimize the possibility of night-flying aircraft colliding with the factory buildings. All in all, Vega's courage in using new techniques have been well justified.

★ ★

LOOK WHAT'S HAPPENED TO AIRCRAFT FABRICS!



An actual copy of Airplane Fabric Specifications from the files of W. Harris Thurston

● Since 1918 aircraft fabrics have come a long way! Notice Point No. 2 in the Army Specifications—"The cotton used shall be Sea Island or Sakallarides Egyptian, with a staple length of not less than 1⅛ inches." These were the finest, strongest cotton fibres known in 1918.

However, in 1941, all-American Pima cotton has been developed and that splendid fibre forms the backbone of Airwing Aircraft Fabrics. More than that, the new fabrics exceed the old in their weight-strength ratio.

W. Harris Thurston has, from 1917 to 1941, been one of the foremost producers of high-performance aircraft cloths. We have helped to perfect the development and control of fine fabrics, better balanced, more dependable. Airwing Fabrics brilliantly possess these qualities.

In other words, the growth and development of finer aircraft have been paralleled by the growth and development of finer aircraft fabrics. Airwing products are ready to meet the needs of 1941.

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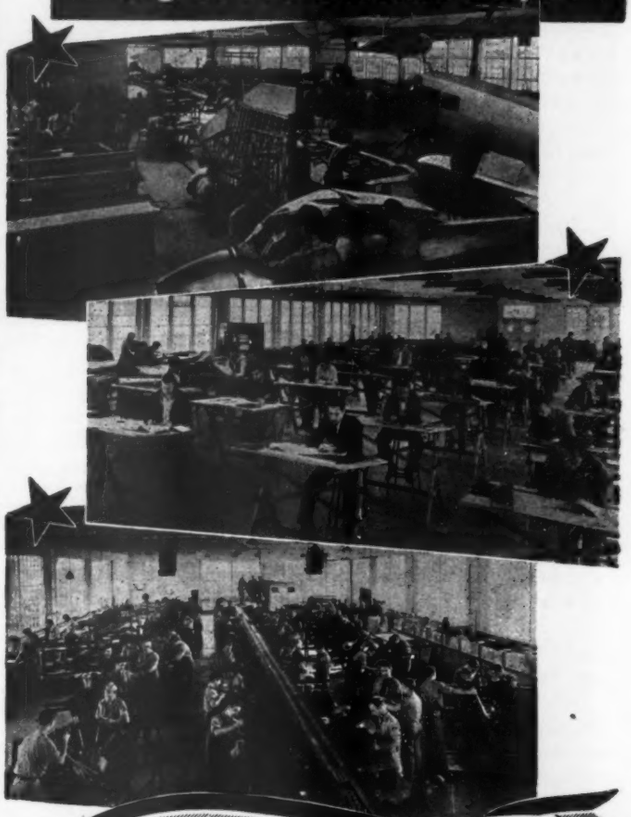

Aero ITI best serves the industry—and thereby national defense—by adhering to true vocational training for craftsmen and mechanics, to true professional training for engineers. The time required, the thoroughness of instruction, and the breadth of technical data and practical skills gained by our students, result in men who can perform more advanced duties at the start, can be key personnel of the immediate future. Thus Aero ITI strives to supply a significant proportion of the type of production and engineering personnel around whom the whole urgent defense production program must be built and expanded.

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Konshin

(*Continued from page 51*)

Two attacks had been made on Barreiras, they told me, before The Man came along. Ten years ago an attempt was made to build a road up the face of the cliff, but it was turned back at the edge of the solid rock precipice that crowns the wall, and Barreiras settled back, an isolated community at the end of navigable waters. A year ago an airport was started below the mesa, but planes could not easily take off without striking the Barrier, and it was abandoned. Nevertheless, American aviation engineers (Panair do Brasil, Pan American Airways) planning the Rio "cut-off" determined that Barreiras was to be the pivotal point, and that the only good site for the airport was on top of the plateau—over the Barrier!

Over the Barrier! That meant that the road—which was called impossible—had to be built in a hurry, to get gasoline and supplies and construction materials ready for the planes that would land on the mesa. Schedules were to start in 60 days. The runway offered no big problems, except that it would have to be made by hand, there being no chance of getting heavy machinery even to the base of the Barrier. There was no skilled labor to be had, no power except human muscles. Planes might drop food, drinking water and medicine, but every foot of finished lumber, every piece of equipment would have to be ferried 2,000 miles from Rio and carried up the cliff. It is hot there, and along the river malaria lurks.

Gas and oil were needed, some 100,000 gallons, and nearly 6,000 items of equipment. Surveyors found they couldn't get to the top of the mesa even on horseback; for the last 200 feet they had to dismount, pull themselves over the ledge foot by foot, and let the animals clamber up as best they might.

This was the time for a man to appear, a man who could do the impossible. Then came George Konshin. He had worked on the Santos Dumont Airport in Rio, and before his American employers could realize it, had taken over the foremanship of construction there. He was the sort of man who always says: "I'll tackle it."

Konshin set out from Rio with a set of blue-prints, a bagful of hard metal coins, a transit and a prayer. He trekked up the coast and down the rivers, over the arroyos to Barreiras.

The village itself on the little Rio Grande and two miles from the mesa, did not cheer him. In it lived about 3,000 people, but they were not workers. Only a handful of able-bodied men could be enlisted for the job, and those were over 40 years of age. "If they had survived 40 years of chronic malaria they could live forever," figured Konshin.

He sent out a call, offering steady work for handling dirt, excellent pay and empty five-gallon gasoline cans as bonuses. To him came fifty Chefes de Turma—local chiefs of the campo—most of them over 70. Each one, in turn, looked at the cliff and shook his shaggy, gray head. Then they looked at Konshin, changed their minds, and nodded! From nearly 100 miles away they came, the Chefes and their little bands of 12 to 20 men, a few scraggly burros, a horse or two, a half-hundred dogs, a score of wives and many children. Household supplies, a black kettle for rice and black beans, a mat to sleep on, a can for water, a needle and thread.

A doctor was first hired, to live with the men 24 hours a day. The men had to be taught to eat; they couldn't work in the sun on their regular diet of black beans and rice, a sliver of dried beef once or twice a week. They had to be guarded against malaria, kept out of the river bottoms where they had always lived, taught to grow a garden, to eat vegetables.

While the workers scoured the country for tools, axes, picks, shovels and every blacksmith that could be found, The Man with transit and stakes laid out the road from town to cliff-top and the first runway atop the mesa. Near a bend in the river he found the clay he wanted, and set others to work building a kiln in which the bricks were to be baked, needed in the construction of the airport buildings. A primitive planing mill was erected; a "human sawmill" devised.

Within a week from the starting-signal, 500 men were clearing brush, stone and dirt from the mountainside on the eight-mile road needed to negotiate the two-mile distance from town to cliff. Divided into groups, they functioned like a well-oiled machine, in double shifts. These men in turn were divided into groups. Those with malarial scars were permitted to work only four hours a day; those without scars toiled seven. Each little group was in charge of its own Chefe.

The line stretched out for miles, spaced every hundred yards by a blacksmith shop, ready to sharpen tools on the fly. Near top-side a special group, trained as masons, were building some of the 17 bridges needed to span the rain-drains, erecting the walls of the bridges, spans and protecting banking of the road—nearly 1,000 yards of stone.

On the mesa, 200 men cleared brush for the runway, digging out stumps, grading as they went, carting dirt in "hammocks" slung between two poles (wheel-barrows could not be brought up). The Man found an old tractor buried in river mud; he mended it with pieces of wood and ordered four spark-plugs from Rio to give it life.

Twenty home-made wells were sunk; they all came in dry. No water on the mesa. But a spring was found lower down, with plenty of good clear water. Later on, a mile of pipe-line was flown in by plane, and put in to bring water up to the plateau.

It was first estimated that the road could get up the cliff in six months; but Konshin bet two boxes of cigars that an oxcart would make it in 30 days, hauling fuel and vital tools. "Get a tractor through from Rio," he ordered. "Send a truck, with two tons of dynamite and drill points!" The truck could beat the dinky railroad that connected the rivers. With the explosive and the drills, he'd get that oxcart over the top if he had to carry it himself.

But the rivers were jammed with fuel shipments, with engine and airplane spare parts, with equipment. The tractor was lost overboard from a river boat. The truck, coming overland through the brush, was plowing along, due in 22 days. The dynamite, which couldn't be flown in, was jammed on one of the rivers.

"Never mind the dynamite", radioed Konshin, "making my own". How he did it, and with what, no one knows and he won't tell. But he blasted through a mile of rock, making a path up the mesa wide enough at first for a burro that could tote four tins of gasoline on each trip. Then he widened it for an oxcart that could carry two gas drums. Doubled its width so that a truck, without its overhanging body, could bring up six drums. Came the final stage, and the truck with ten drums moved up the face of the cliff.

Twenty-nine days from scratch, and the impossible was accomplished! The truck roared over the top in a cloud of dust; all hands broke into cheers. A triumph witnessed by a small army of natives who had toiled, night and day, for so long to build "um casa" for some kind of huge, mystic, mechanical bird . . . natives who had never heard the shriek of a locomotive's whistle, whose closest knowledge of an ocean liner was the puffing little stern-wheelers that plowed their way through the mud-soup of the São Francisco in the season of the Big Rains; whose first view of an automobile was that mass of metal that thundered over the cliff!

The road completed, supplies were rushed over the top. Then the airport and its buildings rose. Runways from

(*Turn to page 172*)

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Republic Aircraft

(*Continued from page 77*)

The surface that is to receive a reproduction of the original drawing is coated with a light-sensitive emulsion and dried. It is kept in a photographic dark room, and, in the case of small drawings, the layout is brought to it. The coated material may be of dural, steel or any other metals, wood, paper, or almost any other substance in this method or in the plastic method explained later. The coated face of the reproduction sheet and the face carrying the original layout are placed together. The reproduction sheet is developed in the customary photographic manner, after it has been exposed for a short time. The exposure is automatic in the sense that the rays of light emitted by the luminescent lines register in the light-sensitive emulsion.

It is interesting to note that in the Republic Aviation Corporation's process, the emulsion is sprayed on to the reproduction sheets. The problem of eliminating bubbles in the applied emulsion has been solved in a very simple manner.

Reproductions made in the above manner are faithful and accurate reproductions of the original, due to the fact that they are made by contact methods.

In those cases where the original drawings cannot be brought to the dark room, the sensitized sheets are carried from the dark room to the loft floor in the light-tight boxes, and by ingenious shutter-like arrangement are placed on the drawing, returned to the box and transported back to the dark room, without exposure to light fogging. A further step in the means of contact reproduction is that of using pigment-coated plastic sheets for the original layout. The drawing is scribed through the pigment coating. Any errors of lines are quickly painted out. Scribing out of the pigment lines desired, and exposing the clear plastic, creates the effect of a photographic negative.

In making a reproduction, the plastic sheet is put in contact with the plate coated with light-sensitized emulsion, and exposed to light for a predetermined time in the usual photographic way. Light passes through these surface-scribed lines, and does not pass through the pigment-coated portions, so that the resultant reproductions, like that derived from the luminescent means, are light fields with darkly-contrasting lines.

An interesting phase of the plastic method permits the development of right and left hand reproductions from the same layout. As an illustration of this, a left hand spar can be drawn and reproduced as a left hand reproduction, then, by turning the plastic sheet over to the reverse side, an absolutely true right hand reproduction can be made. This eliminates completely the additional layout necessary for opposite hands.

In both the luminescent and plastic methods, lines as close as ten-thousandths of an inch apart are clearly developed on the reproductions.

The apparatus necessary for this means of reproduction is not elaborate. No great investment in apparatus is required.

Konshin

(*Continued from page 170*)

all parts of the compass, radio and direction-finder towers, a weather station for upper-air observations. Storage facilities for gasoline and oil. A brick "hotel" with overnight accommodations and iced drinks so welcome in this hot, dry land.

Thus was created Barreiras Aeroporto, the empire of George Konshin, shown on few maps of the Brazilian Republic but which may be of great importance if trouble comes to our big Good Neighbor.

The Man met the plane passengers as they stepped out of the big Douglas DC-3 for the refueling. He took me over to his "palace," a big tent and a few huts with roofs but no walls. He showed me his trophies of the royal hunt, a skull of a Brazilian tiger, or onca, and the huge egg of a Brazilian "ostrich." He was proudest of his two white, gleaming kerosene-electric refrigerators, which had the place of honor in the imperial chamber. And his mosquito netting, much needed.

"The natives never saw mosquito netting before," he observed. "Nor ice," he added.

Konshin introduced me to his wife, Adeljiza, a native Brazilian, who took us to see her menagerie. She pointed to her pets with great pride. There was Caititu, a wild hog which will bite any one but its mistress. There was the goat, Arara, which always goes walking with a large and brilliantly colored parrot. There was an armadillo which she captured near by, the donkey Mariposa, some guinea hens, gorgeous blue and yellow parrakeets and some rather sad chickens.

Back of the "palace" are more thatched huts for about 600 workers. They live here during the week, going home only on Saturdays, for George Konshin doubted if they'd get back to work properly if they tried to "commute."

We started back to the plane as two bells rang, the signal to take off. The wind was stifling; no sea breezes here so far from the Atlantic. Even the Amazon country right on the Equator was cooler. "Does it get cool at night?" I asked Konshin.

"No", replied The Man, "and it doesn't rain between April and November".

The passengers stepped aboard. A few minutes later we were in the cool upper air, putting on coats. The plane roared north. More of the waste tableland country below, and gradually, some hours later, we began to make out rolling green hills, neatly squared farms, a railroad line and straight white highways. Civilization again. Onward, and over the high, foliage-covered mountain range that rims the coast, past Corcovado and Sugar Loaf and down to the wide Santos Dumont Airport in the magnificent harbor of Rio de Janeiro. Our flight, and each one that has followed it, was made possible because of the work George Konshin and his men have done in carving an airport out of the Brazilian wilderness.

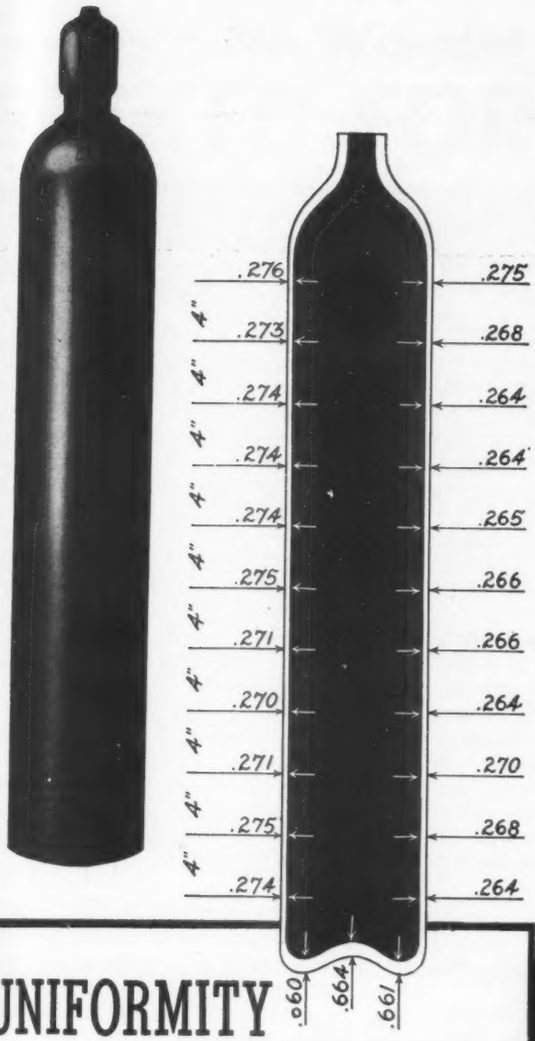
Beaufighter

(*Continued from page 93*)

barrels and aluminum alloy heads, with one reciprocating and oscillating single-sleeve valve per cylinder. Inlet and exhaust ports are provided around the mid-section of the cylinders. Supercharger is of the gear-driven, centrifugal type. Fully automatic, the downdraft carburetor is mounted on the top face of the volute casing and fitted with a once-piece intake having two scoops. One of these protrudes above the cowl line for cold air intake, and the other faces the rear upper cylinder to collect warm air, the supply of which is regulated by a spring loaded shutter under the pilot's control. Engines are mounted by means of the seven rearward-extended crankcase bolts, to which either rigid- or flexible-type mounting brackets may be attached, and housed in close-fitting cowls of low drag.

Performance and specification data which have been released on the Bristol Beaufighter, powered by two Bristol "Hercules" III engines, are as follow:

Span	57 ft. 10 in.
Length	41 ft. 4 in.
Gross weight (without armament)	21,000 lb.
Weight empty	13,800 lb.
Maximum speed at 14,000 ft.	330 m.p.h.
Range	1,500 miles



UNIFORMITY OF THICKNESS

The drawing above is a sectional view of a Harrisburg Cylinder, picked at random as a source of measurements for the making of this chart. Figures at right and left show a variation of wall thickness of only .012 in. Harrisburg Cylinders are available in standard weight Manganese and lightweight Chrome Molybdenum.

Harrisburg also manufactures: Alloy and Carbon Steels, Seamless Steel Cylinders, Pipe Couplings, Pump Liners, Liquefiers; Hollow and Drop Forgings; Pipe Flanges; Bull Plugs and Coils and Bends.

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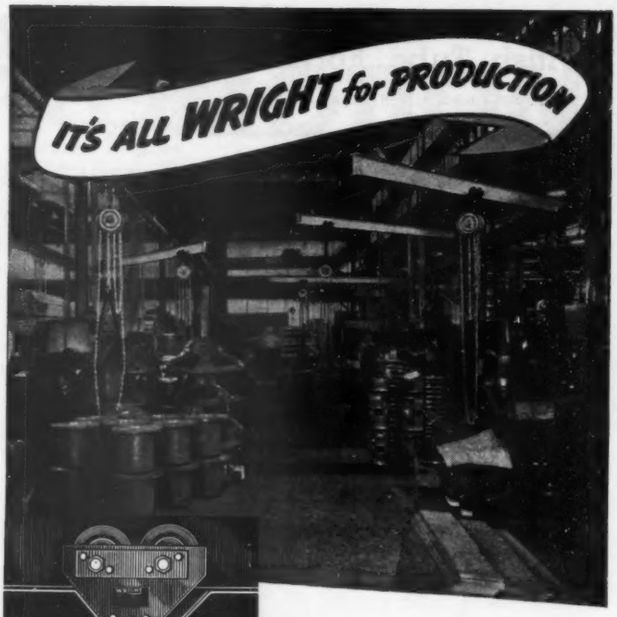

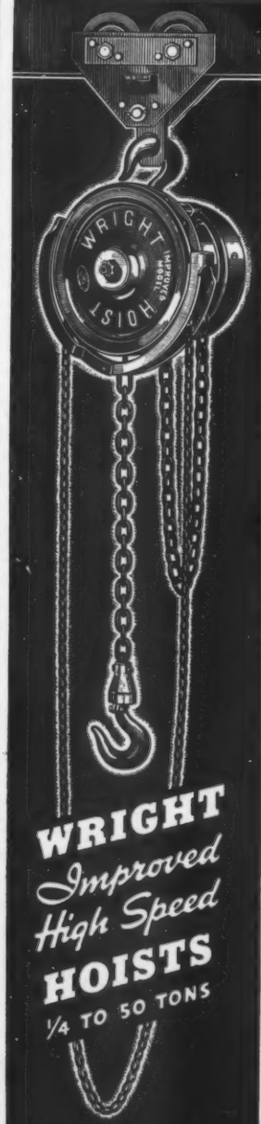

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And safety is inbuilt. The load chain has a safety factor of 7 to 1 and the special process steel of which it is made permits the chain to elongate (because of overload) 3" to the foot before breaking. This same visual factor of safety is inherent in the bottom hook because this hook will slowly open to indicate overload beyond the elastic limit of the chain.

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YORK, PENNSYLVANIA

AMERICAN CHAIN & CABLE COMPANY, Inc.
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British Tube Forming

(*Continued from page 75*)

closed tightly at one end with a cork or hard wood stopper. The boiling water preheats the tube and prevents cold sets during loading.

The molten Cerrobend is now poured into the tube, displacing the lighter water, and when the tube is filled it is plunged *quickly, corked end first,* into a tank of cold water to effect rapid solidification of the alloy and obtain the fine-grained ductile structure desired.

As it has a low thermal conductivity, Cerrobend cools slowly, even when water-cooled, and tube and filler must be left in the cold tank long enough to attain room temperature throughout before bending is attempted.

After bending, the tube is immersed in boiling water to melt out the Cerrobend, then plunged in cold water to solidify any drops of alloy remaining, and cleaned with a pull-through as previously described.

For handling large batches of tubing on continuous production work a permanent arrangement of hot and cold water tanks is desirable. Fig. 1 illustrates the general layout of such equipment. The Cerrobend container is immersed in a boiling water tank and is not heated directly. This maintains the alloy at the correct working temperature and prevents overheating. The water tank may be heated directly from below by gas, by immersion elements, by steam coils, or by any other convenient method.

Tubing of, say, ¼ in. diameter or over is first filled with boiling water from the hot water faucet to preheat it. Then it receives the molten alloy from another faucet. It is then plunged directly into the quenching tank. A useful size for the faucet is one of ½ in. inside diameter, this being big enough to fill large tubes quickly. The faucet can be threaded to take adaptors of smaller size for filling smaller tubing. Tubing of ¼ in. or less is best filled by ladle while standing in the hot water tank.

When tubing is of too small a diameter to be filled from a ladle, the alloy may be drawn into it by suction.

The alloy may be emptied from the formed tubes by immersing in the hot water tank. The Cerrobend is then drawn from the drain cock and returned to the jacketed container for further use. It can be used again and again.

In the molten condition, Cerrobend is so extremely fluid that it will expose any defects, pin-holes, cracks, etc., in the tubing, no matter how minute. Sometimes a tube has passed the most rigid inspection, only to be shown defective by the Cerrobend. If there is a thin spot in the tube wall that has escaped detection, it is sure to be shown up when the filler solidifies and expands, causing a bulge or crack at the weak spot.

It is not within the scope of this article to deal with modern tube-bending appliances. Cerrobend-filled tubes are regularly worked with press tools and any of the successful bending machines. It is important, however, that the bends be made slowly and regularly. Jerky or too rapid application of the bending force should be avoided. Tubes of any cross section are bent as easily as circular stock.

Fig. 2 shows two thin-walled tubes which have been bent to small radii with Cerrobend filler. The complete absence of rippling is obvious.

As may well be imagined, Cerrobend has found extremely wide application in the aircraft industry, not only for the handling of fuel, oil, and hydraulic lines, but also for frame members. Fig. 3 is of interest in this connection, showing an aircraft nose unit in which the tubular frame members have all been formed with this filler.

The Cerrobend method has been applied with marked success to the bending of tubing of aluminum, duralumin, magnesium alloys, steel, stainless steel, copper, brass, monel metal, silver and silver alloys. Tubes plated with nickel or chromium are bent without any tendency for the plating to peel off.

A most valuable development of the use of Cerrobend is in the forming of rolled or extruded sections. The need of complicated rolling machines for this work has been obviated. The procedure is to cast the alloy in a suitable mold in the form of a long metal pan or trough in which the moulding has been suspended. The molten Cerrobend is cast around the moulding and the pan is then quenched quickly in cold water.

The solidified bar of Cerrobend and moulding is then removed from the pan and, after attaining room temperature, is bent to the required shape. It is usually bent around a block of dimensions that allow for the thickness of alloy surrounding the section. Under these conditions (particularly if the bending block is grooved exactly to accommodate the cross section of the alloy block and prevent any cross sectional distortion), it is impossible for the section to ripple or spread in any direction, and perfect bends are achieved. For greater clarity a series of illustrations is given, showing the successive stages of the process.

In Fig. 4 the section is located in a rectangular steel mold in the form of a tube of which one side is detachable and provided with a rubber joint. The thickness of the locating pads or whatever locating device is adopted is known and, of course, determines the amount by which the radius of the block must be undersize to give the required radius to the bend of the section. The detachable side of the mold is then fastened in position—in this case by bolts, but for rapid production work wing nuts or swinging screw clamps would be quicker—and then the assembly is treated just as a tube.

The mold is first filled with boiling water to preheat it. Following this in Fig. 3 it is filled with molten Cerrobend. In Fig. 6 it is plunged into the quenching tank. When the complete mass of alloy has attained room temperature, the mold is opened and the Cerrobend block in which the section is embedded is withdrawn and located in the bending machine (Fig. 7) in which the block is grooved exactly to the cross section of the mold and, therefore, of the alloy block.

Following this the section is bent round the block and is forced steadily into the groove with no change of cross section. The piece is then immersed in boiling water and the Cerrobend melted off, leaving the section formed as required.

Fig. 8 shows a typical section which has been formed this way. Note the complete absence of rippling or spreading. It will be appreciated that the method is applicable to any section, however complex. Sections with re-entrant angles which could not possibly be bent on rollers are bent easily.

As in the case of tubing, sections may be bent in any plane and, with the aid of suitable press tools, formed to any complex curvatures other than arcs of circles.

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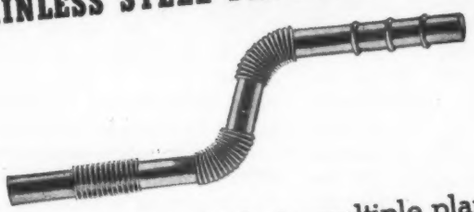

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Flying Test Stand

(*Continued from page 69*)

half what it was at sea level and at 33,000 ft. is one-third. The temperature, at 21,800 ft., is 78 deg. below that at sea level, and at 33,000 ft., it is 40 deg. still colder.

This all sounds very obvious, and it would be if the mass flow (pounds per second) of air through the cooling passages would remain constant. But for the mass flow to remain constant, while the density is reduced to one-half or one-third, the velocity would have to double or triple. And the baffle differential pressure, which forces the air through these passages, varies as the square of the velocity.

As we go on trying to simplify this, it becomes more complicated. But flight test data have been used to establish the relationship between all the variables which affect cooling, and we now have charts ("Cooling Variable Correlation Charts") to facilitate the design of engine cowls. A modern engine cowl gives the engine what cooling it needs, while offering the lowest possible resistance to the plane's foreward motion. This is extremely important on very high speed airplanes, because an improperly shaped nose cowl can give local velocities of the air flow around it, which are much greater than the velocity of the plane. If this velocity reaches the speed of sound, it causes what is called a shock wave, and right there is where speed increases stop. But I'm getting over my depth. Let's go back to the flight testing of engines.

The next thing on our list is accelerations. Of course, you know, it is possible to get accelerations above ten g in an airplane. Three or four g is not at all uncommon. In fact, the light training planes get two to three g's in their practice of so-called vertical banks (70 deg.) Now let's see what these accelerations do to a test problem. As I mentioned before, we are always interested in the pressure of cooling air around the engine, and we practically always measure the baffle differential pressure, which runs from zero to 10 in. or 12 in. H_2O—hydrostatic pressure.

The easiest and most familiar way to measure such a pressure is to use a "U" tube manometer. But, if we use such a tube on a plane, and the acceleration becomes minus one, the liquid is instantly blown or drawn from the tube, because its effective weight has become zero. So we have to land and refill the tube. In place of manometers, we use a dial-type gage built like an aneroid barometer with a sealed case. This instrument has two connections, one to the inside of the aneroid capsule, and the other to the inside of the case. Generally, a study is made of all the pressures in the cooling system, measured against a common base (a static tube on a strut). For such a study, the inside of the instrument case is connected to the strut static tube, and the inside of the capsule is successively connected to the tubes coming in from the various points to be measured. Occasionally, differential pressures are measured directly, by connecting the instrument case to one of the points and the capsule to the other.

Temperatures at many points throughout the engine, cylinder heads, bases, etc., are measured, as well as the oil entering the engine and the oil removed by the scavenge pump. When precision is required, the temperatures taken by thermocouples are measured by means of a potentiometer. This establishes a condition of zero current in the thermocouple leads and cancels any effect the length of the leads or resistance of the switch contacts would have. But the potentiometer is balanced by means of a galvanometer, which has a fairly heavy moving element and a very light spring. The effect of accelerations of the airplane, as a whole, and of vibration on this moving element is very large. Some special instruments have been developed recently which reduce this effect, but it is much better to make these readings while in straight flight, or in a wide circle in which the turn is kept constant, rather than on a course which alternates turns and straight flight. This inertia effect on an instrument is well illustrated by the magnetic compass, which is the worst offender. In the compass, all changes must be made by guess, and then the compass must be permitted to stabilize before you know how near your guess was.

In addition to the inertia effects, we are often bothered by temperatures, which go down to 60 deg. below zero and cause a lot of additional friction in some instruments. In a camera, for instance, the mechanism has actually refused to operate at high altitude until we carefully wrapped it in an electrically heated pad.

Cameras for photographic observation have become necessary because of the physiological effects of high altitude. Observations made by an observer, without oxygen, at above 15,000 ft. are too questionable for use in engine design, and those made at above 20,000 ft. even with oxygen are equally questionable.

Let's take up the matter of atmospheric density and pressure. We touched on this when we considered cooling, but it affects engine operation in several ways. One, the most important of these, is its effect upon fuel, and fuel flow to the engine. I can remember a long way back in the history of aviation, back to a time (during and after the first World War) when "air lock" was an accepted explanation of most every accident which occurred on take-off. In fact, I often wondered how many pilots started to walk away from a wreck, then turned back to open a fuel valve, which they had forgotten, thus providing one more example of "air lock." "Air Lock", was associated with the gravity fuel systems, and it was believed to be caused by fuel line bends in the vertical plane, that is, by the ups and downs of the line.

It is certain that air, trapped in these vertical bends, did cause trouble, but the general use of fuel pumps pushed "air lock" out of the picture. Then high-powered planes and, particularly, high rates of climb brought "vapor lock" in to take its place. "Vapor lock" is basically a pumping problem. So let's review some things we know about pumping liquids, before we take the problem off the ground.

There is an old, old rule which farmers used. "You can't raise water by suction more than 26 ft. If your well is deeper than that, you must lower the pump part way and push the water up from there." Well, that 26 ft. rule is all right for practical purposes, but, of course, the actual limit will vary with the altitude at which the well is located and with the temperature of the water. It is important right now to remember that the temperature affects this limit, and why. At sea level, water can be lifted more than 30 ft. by suction, if its temperature is 50 deg. F. But it cannot be lifted at all by suction, if its temperature is 212 deg. F., because it is then boiling and producing steam which fills the space produced by suction. At 10,000 ft. altitude the boiling point is 193 deg. F. at 20,000 ft. it is 173 deg. F., and at 30,000 ft. it is 156 deg. F. At these altitudes and temperatures water cannot be lifted by suction.

It is difficult to pump water at high altitude, and temperature is important in considering a pumping problem. It is still more difficult to pump aviation gasoline, which boils at lower temperatures than water. Some initial boiling points are: 150 deg. F. at sea level, 116 deg. F. at 10,000 ft., 92 deg. F. at 20,000, and and 68 deg. F. at 30,000 ft. At these altitudes and pressures, "vapor lock" is very difficult to avoid.

Now, it will be all right to take this pumping problem off the ground. Let's make this a tough one, a low-wing interceptor with bullet-proof tanks is loaded with gasoline from a truck, which stands outdoors on a hot day. The gasoline is at 100 deg. F. when it is put into the plane. As the plane climbs, the gasoline remains at the same temperature, because the plane climbs so fast that little

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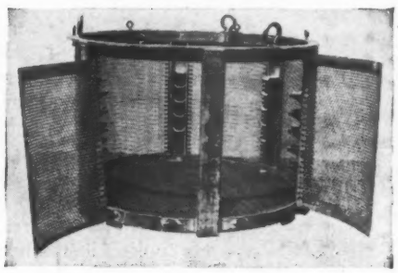

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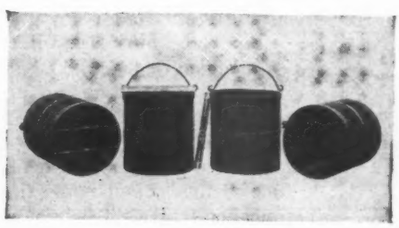

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heat could be transferred through the walls of the fuel tanks and, anyway, the bullet proofing insulates these walls. At 17,000 ft. of altitude, this gasoline is boiling, and it cannot be lifted at all by pump suction. Since this is a low-wing monoplane, the tanks cannot be located high enough for gravity flow, and the fuel must be lifted by pumping, or by pressure applied inside of the tank. If it is to be by pumping, the pump must be submerged, that is, it must be so low that fuel will flow from the tank to the pump by gravity. In that case, the pump cannot be mounted on the engine and driven directly, so it must have a remote drive. Several types of remote drives have been tried out with varying success. These types include flexible shaft, electric and hydraulic. But the problem of pumping fuel is still with us, and when the military services demand more and more altitude, this is one of the reasons the altitude is not always available. The problem is made still more difficult by the fact that gasoline contains dissolved air, which is released at altitude, just as the dissolved air is released from water when it simmers before reaching the boiling point. Even after the pumping is done, and the fuel has reached the carburetor, the job is not finished. The released air upsets the carburetors if it passes through the jets, which are proportioned for liquid gasoline and not for air bubbles. Some carburetors now have separators to remove the air and vapor from the fuel before it passes through the jets.

Fuel is not the only pumping job we have, and altitude affects one other quite seriously. After the oil has passed through the bearings and collected in the sump, the scavenge pump must return it to the tank for recirculation. In the sump the oil is hot, and it contains much air stirred in by the moving parts over which it has passed. Pumping this oil out of the engine is called scavenging, and it offers exactly the same difficulties due to "vapor lock" as does the fuel.

Within limits, the temperature of this scavenge oil can be controlled by the size and location of the oil cooler. As the cooler offers parasitic drag it is kept as small as practicable. As a result, high oil temperature is accepted in the interest of airplane efficiency, but for extremely high altitude it may be necessary either to reduce this temperature, even though a larger cooler may be necessary, or to build the engine with the scavenge pump so located as to run submerged.

One engine, developed quite recently, went through the test stand period with flying colors and encountered scavenge difficulties as soon as it entered the flight test stage. Fortunately, this trouble was cured by a simple change in the scavenge pump suction passage.

These conditions of flight cannot all be duplicated on the ground even as they affect the engine itself. To make the picture complete, you must add in the effects upon the operators (pilot and observers), and upon accessories.

Take the case of the ignition system. As increasing altitude reduces air density, it also reduces the effect of that air as an electrical insulator. All ignition distributors depend upon air insulation. They have been known to fail completely, firing the wrong cylinder when the altitude exceeded their limit.

Supercharging

Supercharging is another, in fact the biggest, altitude problem. But it is one of the problems which is being solved on test stands, because it is not too difficult to simulate altitude conditions in the induction systems, including carburetor and supercharger. Flight testing has done little on this problem except to check results already obtained. In spite of all this, the problem is so intimately connected with much of flight test work that it is worth a brief review here.

Accumulated flight test data show that, at full throttle and constant rpm., the b.hp. of an engine will vary almost directly with the density of the air. At 20,000 ft. the standard density is 53 percent and the b.hp. about 47 percent of their sea-level values. The reduction of density also makes it necessary for the plane to move faster in order to maintain level flight. This increasing speed requires increasing horsepower. The power required goes up, while the power delivered goes down. The altitude at which these two meet is the ceiling of the plane and engine combination.

Supercharging restores the lost density to the air which enters the engine, and also supplies pressure to speed the charge on its way into the cylinder. This has the effect of reducing the altitude for the engine, which can then develop power corresponding to the lower altitude. The result is a higher ceiling for the plane and engine combination.

There are four different arrangements of supercharging systems. The best known is the single stage, which may be either single-speed or two-speed. The single-stage supercharger compresses the charge sufficiently to enable the engine to deliver its rated power at some definite engine speed and altitude. This is the critical altitude for the assembly at that rating, and it may be anything from sea level to several thousand feet, depending on the efficiency, diameter, and gear ratio of the supercharger impeller. But an impeller diameter and speed which is suitable for high altitude is not efficient at sea level, because of the horsepower it absorbs and also because it heats the charge unnecessarily. For these reasons, the high altitude impeller ratio materially reduces the horsepower available for take-off. So the two-speed drive was devised. With it, the impeller is driven at one speed for low altitude and at a greater speed for high altitude. With the two-speed supercharger, there are two critical altitudes and two ceilings.

This is all quite simple, isn't it? Let's go on. The two-stage supercharger gives us an opportunity to cool the air and so remove most of the heat, which the first stage of compression has given it. Of course, the injection of fuel by the carburetor cools the air a great deal, say 50 deg. F. Our intercooler can do its job best by removing heat while the air is hottest—that is, before it enters the carburetor. So the system is arranged that way: first stage of compression—intercooling—carburetion—second stage of compression and through the intake pipes into the cylinders, which put out rated power at about 25,000 ft., compared with about 14,000 ft. for the single-stage two-speed arrangement.

At this point, it might be well to mention that a great advantage of two-stage supercharging is the opportunity for use of an intercooler; and that an intercooler can function effectively only if its surfaces are free from any film of oil. So it is very important that the air leave the first-stage supercharger without any oil whatever. This is not easy and oil film might be expected to interfere with intercooling in many installations.

Two-stage supercharging systems are of two distinct types, depending upon the method of driving the first-stage impeller. If this impeller is gear driven, the system is called a "Geared two-stage", or more briefly, a "Two-stage". If the first-stage is driven by an exhaust turbine, the system is simply called a "Turbo". This last designation may be a bit confusing, because it is generally applied to all systems in which a turbo is used, whether the system is single-stage or two-stage. Very recent military developments are bringing both the two-stage and the turbo systems out of the experimental stage of their development into wider use.

Each of the four supercharger arrangements gives a different critical altitude about as follows:

Single-speed, single-stage 7,000 ft.
Two-speed, single-stage. 14,000 ft.
Geared two-stage..... 20,000 to 25,000 ft.
Turbo first-stage, geared
second-stage ..... 25,000 to 32,000 ft.

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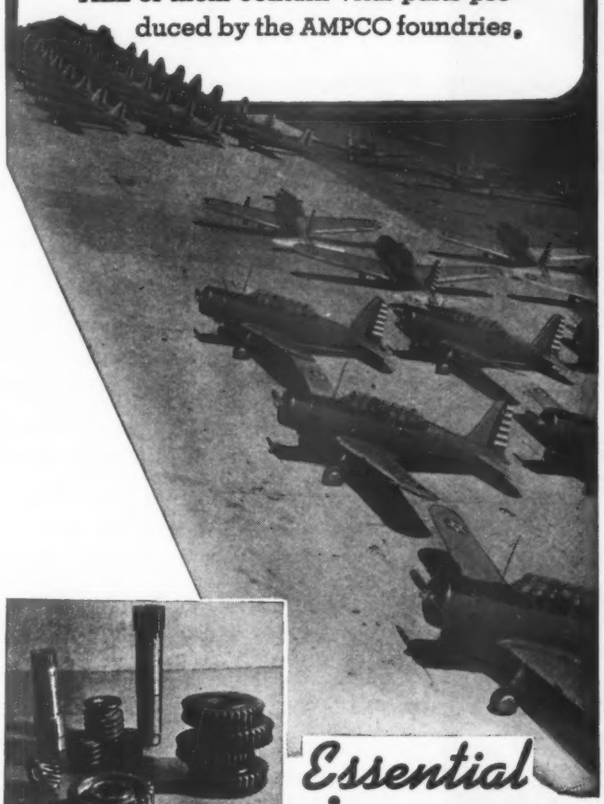

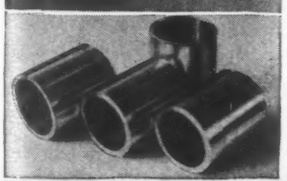

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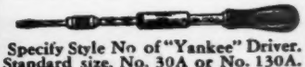

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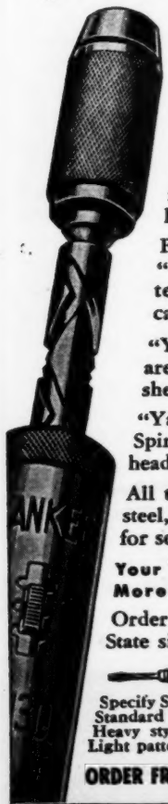

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more data now than it did a few years ago. This increase is due to the use of some new instruments, the most important of these is the torquemeter, which is new enough to warrant a brief description. To make its mechanism completely understood, we can cobble up something to illustrate the principles on which it works. Let's do that before we bother with the compact arrangement on the airplane engine.

Let's take an automobile and jack up one of the rear wheels, leaving the other on the ground. We can rotate the wheel, which is in the air, and the ring gear attached to the differential will rotate at one-half the speed of the wheel. The differential serves as a two to one reduction gear. The wheel, which is still on the ground, holds stationary the gear to which it is attached. If we jack up that wheel, too, we can keep it from turning by means of a spring scale attached to the rim, or to one of the spokes. Now, we can measure the effort required to prevent rotation. Except for the effect of friction, which can be corrected, the turning effort on one wheel is equal to the effort required to prevent the turning of the stationary wheel. This arrangement contains all of the essentials of the Wright torquemeter. The automobile differential gear functions exactly as does the Cyclone reduction gear: the ring gear takes the place of the propeller shaft and its attached parts, the stationary gear acts the same as the sun gear of a Cyclone. The gear attached to the rotating wheel serves the same purpose as the "Bell gear". The scale and its attachment to the wheel replace the torque balancing piston and torque arm. The scale spring and dial are substituting for a hydraulic load and a pressure gage.

The many cumbersome and questionable computations to determine the horsepower delivered by the engine in actual flight are no longer necessary.

The difficulties experienced in the pumping of fuel have been equaled by difficulties in measuring fuel flow, and for the same reasons. There has been progress in fuel-flow meters also. A recently developed meter uses a permanent magnet, which is located in the stream of fuel. The magnet "windmills" as the fuel flows by, and its motion generates an electro-motive force in a coil attached to the fuel pipe at this point. This electro-motive force actuates the indicator on the instrument board and indicates the fuel flow in gallons per minute, or pounds-per-hour, or whatever units you prefer.

And now that our test airplane has become a flying dynamometer test stand, with accurate fuel flow measurements, I find that we have done what our young engineer wanted us to do, "Take test stand conditions into the air."

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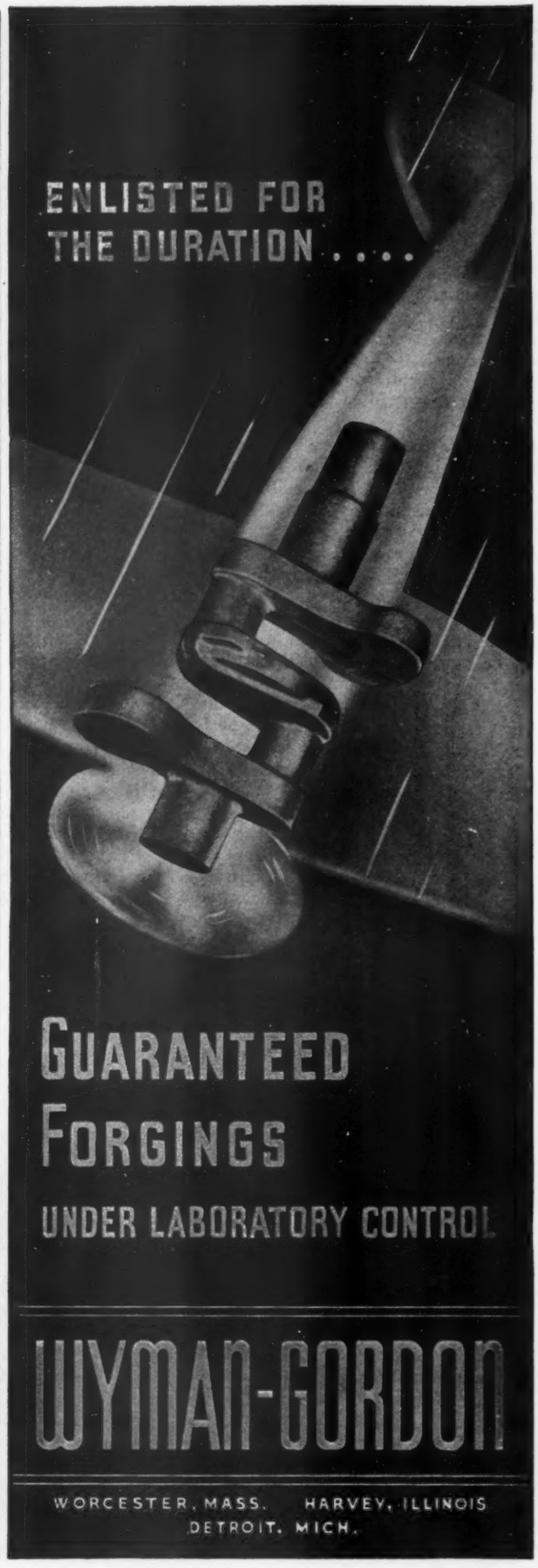

Specification Engineering

(*Continued from page 57*)

illustrations prepared by our staff artist, J. E. Davis, and by photographs when available.

During contractual negotiations various members of the engineering department confer with the customer. One member of the specifications engineering group, usually the Specification staff engineer, is there to translate the customer's requirements into the contract specification.

The form of the "Expanded" specification we use has been stabilized to make possible the use of the same paragraph number for similar paragraphs of specifications for all models. This facilitates the preparation of specifications by various members of the group and permits comparison of different Lockheed airplanes by prospective customers. The quantity and type of engineering information contained in the sales and contract specifications is governed by the status of the design work and the requirements of other departments such as production, sales, legal, etc. Information released is always subject to approval of the chief engineer, project engineer, and sales organization.

General arrangement of the "Expanded" specification is such that it can be reduced readily to a "Contract" specification by removal of those sections not applicable to the particular airplane, and by adding items of special equipment desired by the customer. However, at the time the contract is signed the customer does not always know exactly what he wants with regard to some minor items. In such case options are included in the contract and in the contract specification, definitely setting forth the proposed option and stating all price, weight, and delivery date changes attendant upon exercising the option. This allows the customer a specified additional time to study the particular requirement, but does not delay engineering in the meantime.

Since the first price is set by the specifications, changes to the specification, and thus the complete airplane, must necessarily include all effects on the contract and the specification as that change affects it. One change may affect many items such as price, delivery data, strength, performance, interchangeability, weight, acceptance, etc. The specification group is responsible for issuing all proposed changes to contract specifications, as required, initiated either by Lockheed or the customer. Upon approval by the chief engineer, the proposed changes are forwarded to the contract administration division for coordination with the customer and the contract.

The basis for the preparation of all design directives is written instructions issued by the chief engineer. These instructions are supplemented by additional data of a general nature which have the approval of the chief engineer or chief research engineer, as indicated by written communications on file in the engineering specifications office.

A draft of the proposed design directive is prepared and submitted for comment to the project engineer, the chief engineer and, in addition, the various sections pertaining to such items as power plant installation, electrical equipment, etc., are submitted to the staff engineers and appropriate group engineers on the project. One or more additional drafts are then prepared incorporating all changes and additions requested by various parties concerned and are resubmitted for correction and approval. This function replaces the personal contact which was possible when the company was smaller.

After approval of the draft, the design directive is typed on master ditto and issued in a preliminary form for the purpose of securing comments and suggestions from group supervisors, staff engineers, sales, and sometimes the customer. The "preliminary" issue is recalled in a week or ten days for revision as the first official issue. Thus, the entire resources and experience of the engineering department and other allied departments are drawn upon. This work must be carried out in the shortest possible time if the directive is to be of maximum usefulness. At this time eight separate types of Lockheed airplanes are covered by active design directives.

A design directive for the revision of an existing airplane consists for the most part of (1) general design data and (2) a list of only the changes to be made to the existing airplane to accomplish the redesign of the projected modified airplane.

A design directive for an entirely new airplane is a comprehensive specification covering the general arrangement and all features of design. To date, three design directives of this type have been issued in the Lockheed engineering department.

In an engineering department as large as Lockheed's (1,260 as of this writing), and on a commercial project of such size as the Lockheed "44," it is necessary to have coordinated, detailed, design information readily available to the engineers (and our representatives away from the main plant) on the project at all times. Obviously the Civil Air Regulations are too general to serve the purpose. In the case of a design for the Air Corps, the problem is simplified because the "Handbook of Instructions for Airplane Designers," together with a "model" specification, serves as a source for virtually all primary design information. The complete adaptation of Air Corps and/or Navy Department design data to a commercial project is neither desirable nor practical for three reasons: (1) basic design criteria for a commercial airplane differ substantially from that for a military airplane, (2) the military design data cover various types of airplanes and much of the information is not directly applicable to a commercial transport, (3) military design data are restricted and therefore not available to the extent desired.

The procedure, then, to achieve the desired end is to (1) extract applicable data from airplane specifications and equipment agreements for airplanes of comparable size and design, and (2) review applicable data from and refer to the requirements of the CAA, Navy Department's specifications SD-24D, and the Army Air Corps "Handbook of Instructions for Airplane Designers." This procedure provides data covering recent trends in general design, arrangement and equipment; provides the engineering department with design information compiled through many years of service experience and extensive research, and refers to and clarifies the latest mandatory requirements of the CAA. All design directives are amended and revised as frequently as required, depending on the scope and activity of the project.

Considerable correspondence is carried on in conjunction with work on specification and design directives. In a recent three-month period the specification group had written approximately 1,250 letters and inter-departmental communications. In addition, a procedure has been established whereby all correspondence from the engineering department, directed to the Air Corps and all other government procuring agencies, is routed through the specification staff engineer's office for coordination before release to the contract administration division of the sales department.

As a part of the work of the specification group, a comparatively new system of Lockheed model designations has been set up. A Lockheed model designation consists of a two-digit basic model number with prefix numbers to indicate modifications, followed by a two-digit power plant code number, and a two-digit interior arrangement identification. As an example, take the Model 414-08-01. This airplane is the

(*Turn to page 184*)

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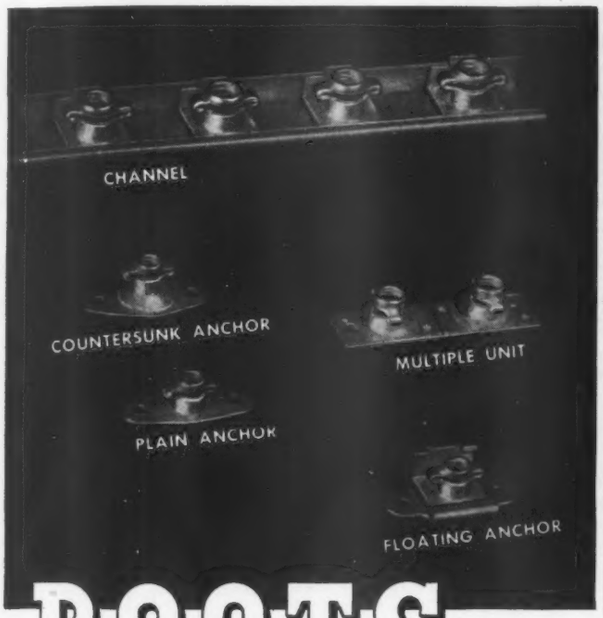

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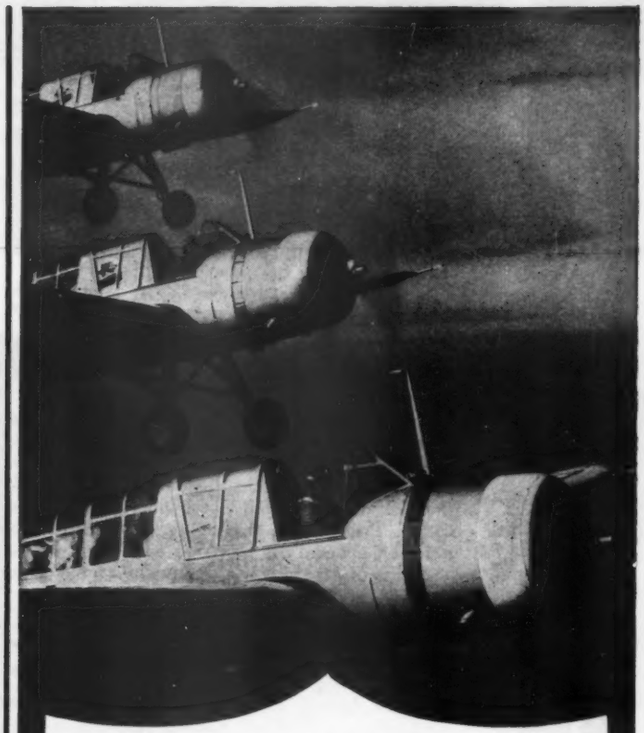

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Specifications

(*Continued from page 182*)

fourth modification of the Model 14. It has an 08 power plant, meaning Pratt & Whitney R1830 SC3G engines. It has the first interior arrangement developed for the 414 series of airplanes.

The specifications and related data prepared by the specification engineering group are used by many Lockheed departments both at "home" and away from the plant. The activity of the group, therefore, is closely coordinated with outside departments. From the beginning of the project until long after production is completed and delivery made, our activity is concerned with supplying all vitally interested parties with essential information.

Specifications as Sources

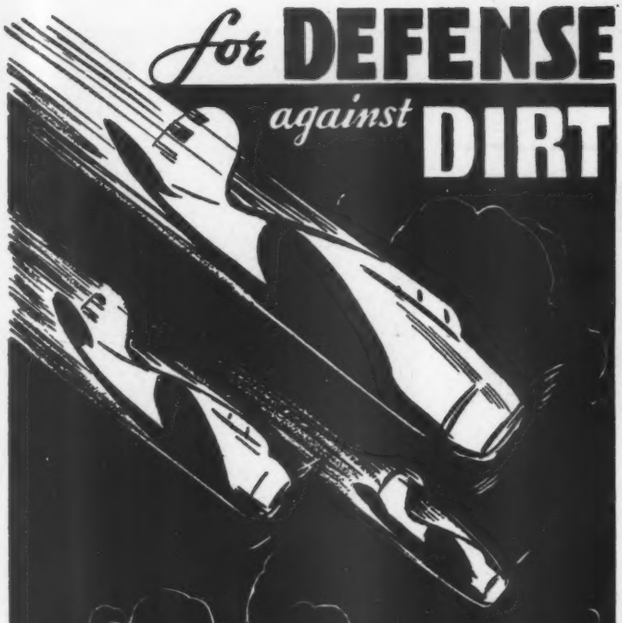
The specification assists the estimating department in establishing a price, the production department in preparing delivery schedules, and provides the sales department with factual data for presentation to the customer. The design directive assists both engineering and production planning in scheduling the work to be accomplished in accordance with contractual commitments. To illustrate the volume of work during the last year, for example, 500 reams of ditto reproduction paper were used in our department. At present we are working with 48 active specifications covering 28 active models.

However, the program of the specification engineering group cannot be based on what is normally classed as active models because our schedule must anticipate the preparation of bid data on many projects which never become active insofar as the remainder of engineering and the factory are concerned. In addition to successful bids resulting in more than 40 contracts covered by contract specifications, bid data have been prepared covering about 10 incomplete bid transactions in the last 18 months which, if completed, would have resulted in approximately another eighty million dollars worth of business.

During the past 18 months we have submitted data to 13 foreign countries, as follows: Brazil, Canada, Chile, China, Dutch East Indies, England, France, Greece, Holland, Honduras, Jugoslavia, Turkey and Venezuela.

While the major effort of the specification group today is concentrated on military work, having laid the foundation months ago, they are, however, planning for the time when airlines will be ordering the transports of tomorrow.

for DEFENSE against DIRT



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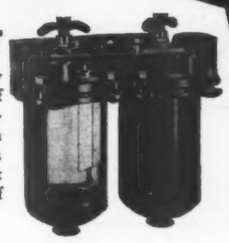

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A. Sept. 1941

CAA And The Buyer

(*Continued from page 89*)

ties and by consistently producing airworthy products, random inspections are made. Parts in process and completed products are checked for conformity with approved drawings.

Again referring to the procedure of Interstate, CADETS are built in subassemblies. For example, the fuselage is built up in sectional units, bottom section of the cabin, side sections and adjoining units leading back to the vertical fin assembly. This permits a thorough and convenient inspection of each sub-assembly as it is built, much more simple than making a thorough inspection of a complete fuselage on a larger jig.

Frequent inspection of tools, jigs and dies is made to determine their fitness and accuracy.

From raw materials in the stock room, through first stages of subassembly, to the completed fabrication of component parts and on through finish and final assembly, the inspector has watched the airplane progress to completion. By a sampling system of inspection, he has checked it thoroughly and when the flight test has been completed and the plane is pronounced airworthy, and ready for delivery, his signature on the license of that plane is the purchaser's assurance that he is receiving a product built in accordance with regulations of the C.A.A. which are designed to assure the user that he is receiving a safe airplane.

Following painting and doping, each unit is examined for possible defects.

The Continental engine installation is carefully scrutinized by the author.

The finished airplane is carefully weighed to make sure it conforms to A.T.C.

Every airplane owner is given a C.A.A. certification as ship leaves the factory.

Bird Flies on a Wing and a Half

(*Continued from page 61*)

Maintenance Superintendent Z. Soldinski, and Chief Pilot H. L. Woods went into a huddle, with the result that a DC-2 wing was bolted to the belly of another DC-2 and was flown to Suifu. Arnold Weier and a few coolies installed it on the DC-3, inspected shrapnel holes for damage to main members, put a few cloth and dope patches over the worst of them and pronounced the plane "airworthy"—with a few reservations.

To appreciate the technical aspects of this feat, you must realize that the DC-2 and the DC-3—while of the same type, are very different airplanes. The DC-2 is a 14 passenger plane with a maximum weight of 18,600 pounds and a wing span of 85 feet. The DC-3 is 21 passenger with a gross weight of 24,400 pounds and a wing span of 95 feet. The base or butt of the two wings and the fittings are identical but there the similarity ends, the DC-2 wing was designed to carry only about 75 percent of the gross weight of the DC-3. Theoretically it was not possible—the shape, area and taper of the two wings are entirely different.

CNAC Captain H. L. Sweet, who took a "bussman's holiday" a few months ago to fly bombers to England for the British, flew the wing up and the DC-3 back to Hong Kong and in telling about it afterward "had surprisingly little trouble." The DC-2 handled almost normally, except that the drag of the extra wing reduced his cruising speed to about 115 mph. There was no noticeable interference with the slip-stream over the tail surfaces and the take-off was normal.

The test top on the DC-3 at Suifu, with a very light gas load and Arnold Weier as observer, was without incident. It was natural to expect that the plane would have a tendency to "roll" toward the DC-2 wing and allowance was made for it; with an aileron tab setting of twelve degrees and a slight difference in propeller r.p.m. the plane flew straight and level. The return trip to Hong Kong was made at an average true air speed of 145 mph. Another "impossible" in aviation had been accomplished—and we will have the plane back in service within a very few days.

The DC-3, in Hong Kong, represents an investment of more than 130,000 U. S. dollars and the DC-2—another $96,000. If there had been any miscalculation, either in the engineering angle or in the flying of the two ships, it would have been a sad day for us. It took courage (or something) on the part of all concerned, engineering, flying and last but not least—accepting responsibility for approving the screwy idea.